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AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY

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[illegible] YEARS OF RESEARCH ON MAN IN FLIGHT

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This 50th Anniversary Celebration is a gala review of the last half century of research in aviation medicine. This research has fundamentally shaped the evolution of aircraft design from the wood and wire biplanes to the Space Shuttle. Many renowned scientists have worked in this creative multidisciplinary environment, to evlove pioneering knowledge and established World records that have stood the test of time. Their numbers are legend. Their efforts are unsurpassed anywhere in the world. The published literature from 1935 to 1985 has set the standard for air vehicle design in this country and abroad. Wherever man interfaces with the air vehicle, the mark of aeromedical research is clearly evident in both the hardware design and its functional operation. It is the integration of engineering and medicine which made these achievements possible. The next half century will make even bolder strokes in manned flight.

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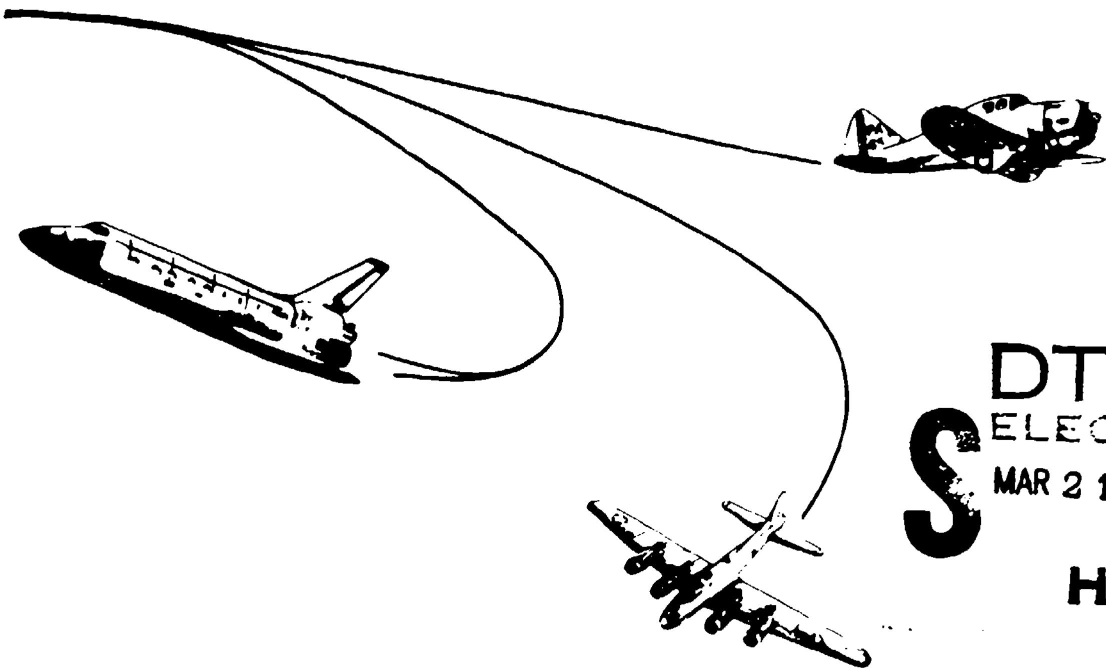
LABORATORY

50 Years Of Research On Man In Flight



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AUTHOR

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WRIGHT-PATTERSON AFB, OHIO 45433

AERO MEDICAL LABORATORY

"The primary mission is to provide the necessary technical information based on scientific research, to enable the aeronautical engineer to design aircraft which are best suited to the mission without surpassing the physiological or psychological limitations of its crew"

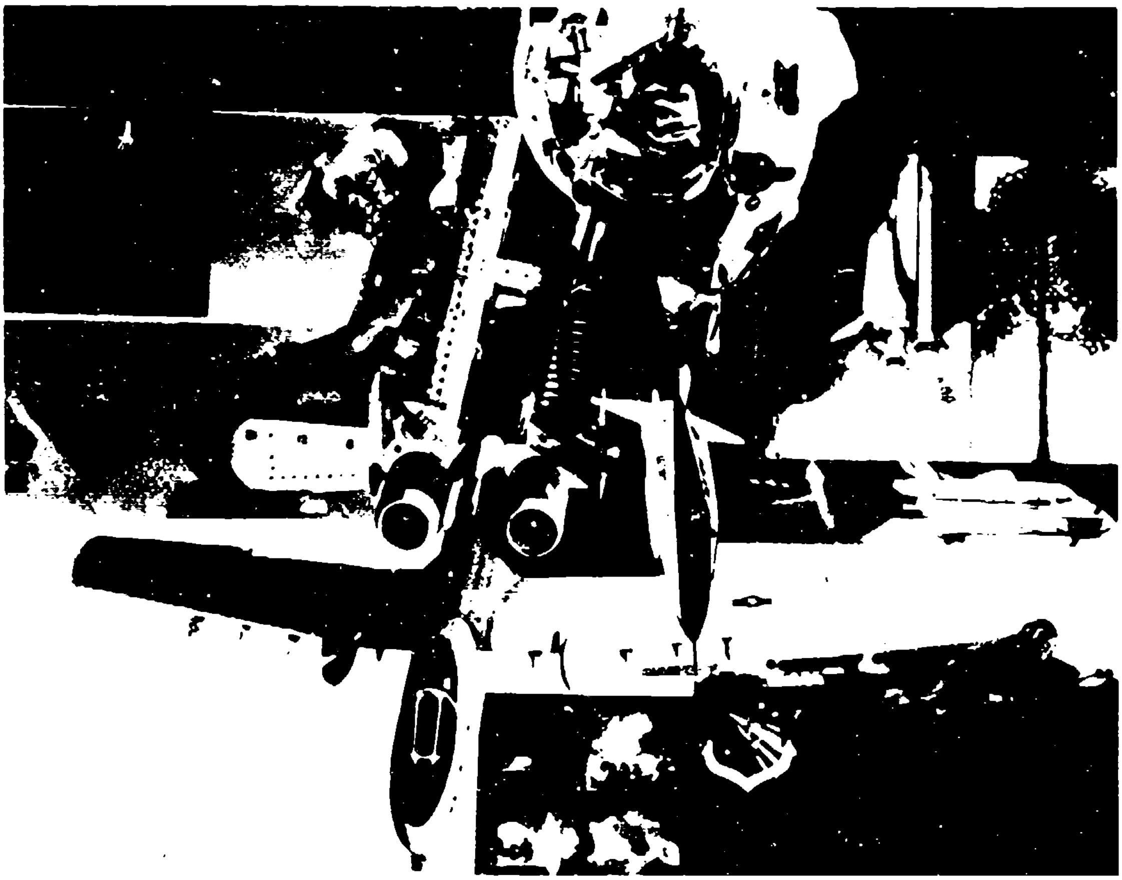
Colonel Jack Bollerud

COMMANDER, AERO MEDICAL LABORATORY

1955

Colonel George C. Mohr
COMMANDER A.F. AEROSPACE MEDICAL RESEARCH LABORATORY

The Air Force Aerospace Medical Research Laboratory marks fifty years of achievement and service to the nation. From the beginning, the Laboratory and its people were dedicated to enhancing personnel safety and mission effectiveness through research contributions to advanced system design and military operations. The Laboratory today is a renowned center of excellence for research in toxicology, biodynamics and human engineering. Its many contributions to life support technology, environmental hazard control and crewstation design have in a very real sense made modern manned weapon systems capable instruments in defense of our nation. Through analysis, simulation, human and biological experimentation and model formulation, laboratory scientists seek to enhance man and mission in the tactical, strategic, command and control and ground operational arenas. The Laboratory has unique facilities and multidisciplinary scientists able to extend man's reach with each advance in systems technology. The Laboratory is ready for whatever challenge awaits in the next fifty years.



AFAMRL AND A CENTURY OF FLIGHT

This 50th Anniversary Celebration is a gala review of the last half century of research in aviation medicine. This research has fundamentally shaped the evolution of aircraft design from the wood and wire biplanes to the Space Shuttle. Many renowned scientists have worked in this creative multidisciplinary environment, to evolve pioneering knowledge and establish World records that have stood the test of time. Their numbers are legend. Their efforts are unsurpassed anywhere in the world. The published literature from 1935 to 1985 has set the standard for air vehicle design in this country and abroad. Wherever man interfaces with the air vehicle, the mark of aeromedical research is clear... evident in both the hardware design and its functional operation. It is the integration of engineering and medicine which made these achievements possible. The next half century will make even bolder strokes in manned flight.

50th ANNIVERSARY CELEBRATION COMMITTEE

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Mrs. Patricia Lewandowski	Program Coordinator
Dr. Henning von Gierke	Chairman Technical Symposium
Mr. Kenneth Zimmerman	Announcements, Social Functions
Mr. Steve Heckart	Memorialization of Bldg. 248
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Lt. George Sarmiento	Exhibits and Displays
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MSgt. Anthony Smith	Rededication/Renaming Laboratory
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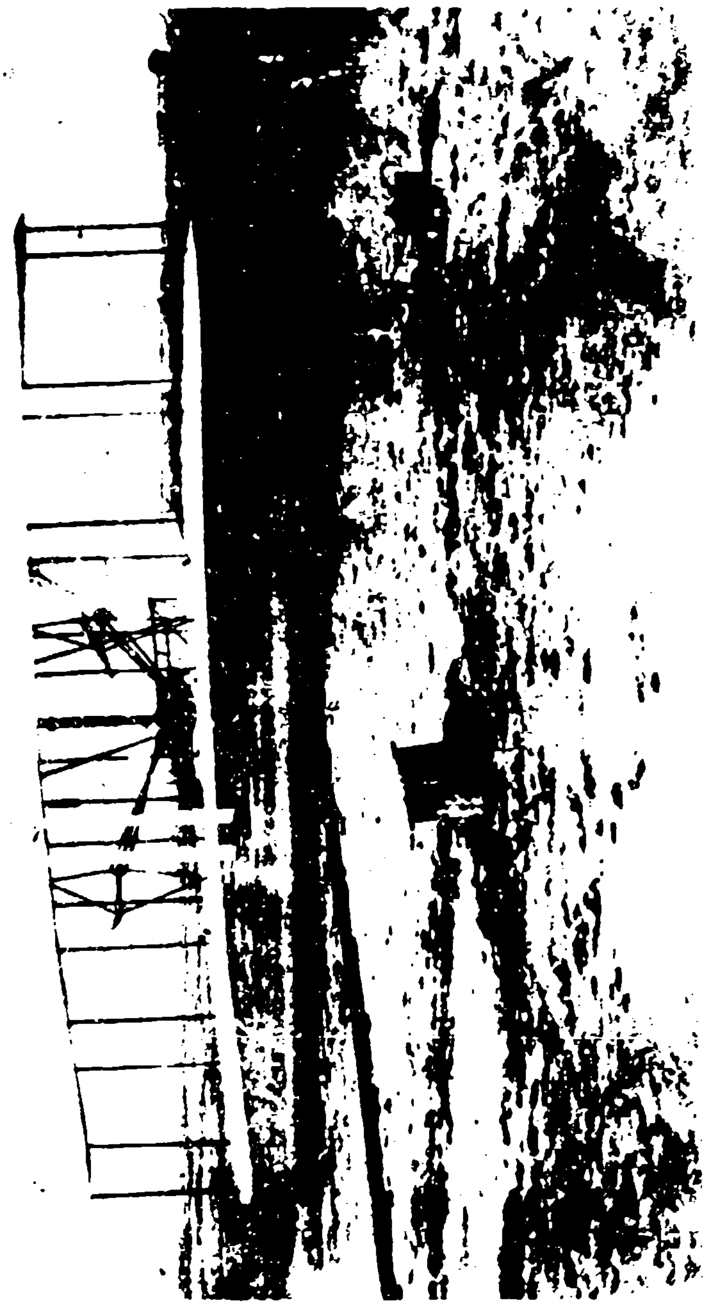

Fig 3 First Powered Flight, December 17, 1903

THE PIONEERS OF MANNED FLIGHT

Orville and Wilbur Wright were the first men in history to develop and successfully fly a heavier than air machine. Many men had attempted this goal but they all failed before the Wright brothers began their activities.

The Wright "Kitty Hawk" Flyer permitted man to fly and also be exposed to the unknown environmental conditions of flight. The brothers were often unaware of the environment and yet were the first to experience: multidirectional acceleration forces, flight control coordination while trying to maintain their own physiological equilibrium, abrupt acceleration forces during crash landing, unprotected wind forces in flight, thermal physiology limits while flying in cold weather, high propeller and engine noise in the cockpit.

They first encountered negative accelerations while flying the 1902 glider at Kitty Hawk. This negative acceleration forced the pilot's body up and away from the prone position cradle. With his body out of the cradle, he could not use the lateral wing warping flight control. The pilot did not have a body restraint system. He held on to the vertical wing strut with his right hand and tried to pull his body back into the cradle with his left hand, which was holding the flight control stick. This forced him to move the pitch control stick aft and fly the airplane into the dangerous stall spin condition which had killed Lilienthal.

The first powered flight was made on December 17, 1903 at Kitty Hawk. The wind velocity was 25 MPH with high gusts. There was ice in the small ponds around the sand dunes. They had no winter flying clothing. The Flyer could simply not carry the additional weight of protective clothing. The gusty winds acting on the 745 pound airplane required rapid and coordinated control movements by the pilot. They were flying between one and ten foot altitude in those gusts. This type of vertical movement along the flight path produces vertigo in the most experienced pilot. The Wrights had only 20 minutes of pilot time in gliders before their first attempt with an engine and two propellers.

It has been proven from the beginning of manned flight that aero medical research is fundamental to aeronautics. Captain Harry G. Armstrong emulated the Wrights in aero medical research. His initial efforts and the next five decades are the "GOLDEN ERA OF AVIATION."

Charles A. Dempsey

ACKNOWLEDGMENTS

Colonel George C. Mohr, Commander, Air Force Aerospace Medical Research Laboratory, provided the leadership and command emphasis essential for this project. He was always available for discussion and guidance during the preparation of this book. Mr. Billy Crawford, Chief, Plans and Programs, did an outstanding job of providing management support. He constantly made Laboratory resources available to the project. The author was given a free hand within the boundaries of his charter, and he alone decided which events would be included in the book as well as how they would be presented. The highly diverse nature of the Laboratory activities plus the fifty years of research information prevents a detailed discussion of all the work in the Laboratory. The selected projects provide the reader with an understanding of the scope and complexity of the overall research and development program. There are many dedicated scientists who worked on programs which are not discussed in this book. Their efforts are just as important to the Laboratory and the Air Force as those selected for review. Complete historical documentation of the entire Laboratory needs to be written in the near future.

Thanks are due to the many EARLY YEARS veterans. They have contributed anecdotes and details which helped to fill in gaps in the early history. Special acknowledgement is due to the colleagues of the founder; Dr. J. W. Heim, Dr. Ernest Pinson, Mr. Ray U. Whitney, Mrs. Mae (Callen) Poszywak, Mr. John Hall, and Mrs. Patricia (Crane) Lichty, wife of M/Sgt. Harold Lichty (deceased). They were there from the beginning with Captain Armstrong. These are the true pioneers of the Physiological Research Laboratory. They gave generously of their time for interviews and supplied photographs and documentation from their private collections to supplement the Laboratory historical material.

Special mention is given to the WAR YEARS veterans who first occupied Building 29. The author worked with different members of this group over the past thirty years. In this long association he obtained valuable background information and technical understanding of the research work conducted in the Laboratory. They are Mr. Ernest Martin, Dr. Harvey Savely, Mr. Don Huxley, Colonel Mike Sweeney (deceased), Dr. Fred Berner (deceased), Mr. Charles Castellano, Colonel Pharo Gagge, and Mr. Donald Good (deceased). These men were involved when the research was fast and furious in support of the war effort. They often made the impossible look easy and achieved many firsts in science and biotechnology.

My very dear friend, Mrs. Joan Robinette, was the Laboratory Scientific and Technical Information Officer (STINFO). Her services in this capacity made possible the many thousands of technical reports and papers which have been published by the Laboratory. This experience prompted her to organize a chronology of the Laboratory and maintain historical copies of all this material. Her work has been one of the prime reference sources for this book. She was truly the guardian angel of the historical material in the Laboratory.

The outstanding work of Mr. John Bullard, Historian, Aerospace Medical Division is acknowledged. This renowned author prepared the semiannual and annual historical documents for the Division. They are meticulous with regard to dates and research programs. His work is the other prime reference source for the material in this book. His special efforts in obtaining detailed personal interviews with leaders in aeromedical research is without parallel. These first person documents cleared the blurring effects of time and made the understanding of reality possible. The author extends special thanks to him for his writings which often went unnoticed.

These acknowledgments would not be complete if I did not give particular thanks to Dr. Walter Grether, Dr. Henning von Gierke, Mr.Charles Bates, Dr. Bruce Stuart, Mr. Steve Heckart, Mr. Ray Whitney, Mrs. Patricia (Crane) Lichty, Mrs.Mildred Pinkerton, Mr. Jim Brinkley, Dr. Charles Nixon, Mrs. Joan Robinette. They reviewed the text and furnished creative contributions to the book.

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Many members of the Aerospace Medical Research Laboratory generously provided historical information to this project. Especially noteworthy were Mrs. Pat Lewandowski, Mr. Kenneth Zimmerman, Mr. Steve Heckart, Mr. John Frazier, and Mrs. Don Rosenbaum.

The creative art work was provided by Mrs. Virginia Greene an outstanding artist in the Laboratory.

The final thanks go to my Southern bride; without her help the book would not have been completed.

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Fig 4 M/Gen Harry G. Armstrong

FOUNDER

PHYSIOLOGICAL RESEARCH LABORATORY
EQUIPMENT BRANCH
ENGINEERING SECTION
MATERIEL COMMAND
U. S. ARMY AIR CORPS
WRIGHT FIELD, DAYTON, OHIO

On May 18, 1935 Captain Harry G. Armstrong was appointed Chief of the Physiological Research Laboratory at Wright Field, Ohio. This event placed Captain Armstrong on an ascending path leading to international acclaim and distinguished service to his country. From the outset, Dr. Armstrong was intimately familiar with the harsh environment confronting the military aviator; extremes of heat and cold, noise, windblast, oxygen want, noxious fumes and severe acceleration forces contributed to physical and mental fatigue taxing even the best pilot's ability to control his unforgiving aircraft. Today, Major General Harry G. Armstrong is recognized as one of the great pioneers in aviation medicine. His contributions to aeromedical research have yielded inestimable benefits to flying safety and mission effectiveness. This volume recounts the history of a living organization and the life of an outstanding individual. With great pride, this book is dedicated to the memory of Major General Harry G. Armstrong, the physician, the scientist, and pioneering founder of the Air Force Aerospace Medical Research Laboratory.

PROLOGUE

Aeronautical research and development projects were established at McCook Field, Dayton, Ohio, in the autumn of 1917. The Airplane Engineering Department was the center of all new aircraft design and development. In August 1918, this department was retitled the Airplane Engineering Division and reported directly to the Chief, Army Air Service. The new Engineering Division was subdivided into five units. The Aircraft Branch, Equipment Branch, Armament Branch, Engine Branch, and Materials Branch.

The Army Air Corps was formed in July 1926 and the resulting organization changes produced the Materiel Division at McCook Field. On October 12, 1927 the Materiel Division moved to the new Wright Field facilities. The engineering function was located in Building 16. The organizational chart was revised on June 19,1928 to reflect a new type of management structure. There was the Engineering Section, Procurement Section, Field Service Section, Repair Section, Industrial War Plans Section and the Administration Section. The Experimental Engineering Section contained the Airplane Branch, Equipment Branch, Armament Branch, Power Plant Branch, Lighter/Air Branch, and Materials Branch. The Administration Section had the Medical Branch and other base service functions. The Medical Branch was a dispensary. When requested it also provided medical assistance to the engineering organizations located at Wright Field. Captain Eugene Reinartz was Chief, Medical Branch, in 1928. Major Reed was Chief, Medical Branch in 1934. The Equipment Branch engineers, prior to 1935, frequently requested medical assistance when they were conducting experiments involving human subjects in their altitude chambers.(The large chamber was formerly located at Mineola, New York).

Major Borum was Chief, Equipment Branch, on January 1,1937. The Equipment Branch contained six Laboratories; Instrument & Navigation, Electrical, Parachute & Clothing, Aerial Photographic, Miscellaneous Equipment, Physiological Research. The Equipment Branch was responsible for research, development, and standardization of 500 items of ground and air equipment. This overall management structure remained unchanged from 1928 until early 1942 when it was reorganized into the Materiel Command.

The Experimental Engineering Section was an active and lively technology center. Its hallmark was entrepreneurship and a do-it-yourself-spirit. It was responsible for the development of all new aircraft and equipment for the Army Air Corps. In the period 1925-1934, engineering worked on 380 different aircraft designs which resulted in the production of 3823 airplanes. During 1935-1940 the development types totaled 97 and the aircraft quantity was 2532. The average annual assigned strength was 89 officers, 23 enlisted, and 1127 civilians. Major Howard was Chief, Airplane Branch, and Captain Oliver Echols was Chief, Equipment Branch, in 1928. There were many young engineering pilots assigned to the Airplane Branch and the Equipment Branch. These intensive aircraft and equipment development programs produced a significant number of aviation achievements and some of these pilots became world famous. Typical examples were 1/Lt James Doolittle, Captain Oliver Echols, Captain Albert Stevens, Captain Anderson, 1/Lt Albert Hegenberger. In 1934 a young medical officer, Captain Armstrong, was assigned to this center of aircraft research and development. These pilots were Armstrong's daily working associates, his friends, his flying companions. In addition, Armstrong was their flight surgeon, an immortal bond that is steeped in military aviation tradition.

Documented first person history statements, by respected scientists who worked on a daily basis with Armstrong, provide an intimate view of this medical pioneer. He was a dedicated medical officer, soft spoken, with great personal charm and possessing a strong loyalty to the service. He was quiet, relaxed, with a self-assured manner. No thrashing about, no hurried pace, no long overtime hours, yet everything he did seemed to count. As an outstanding characteristic, he appeared to thoroughly enjoy everything he did and his enthusiasm was infectious. An almost undetected talent was his ability as an entrepreneur par excellence. With his disarming yet convincing manner, he was a master of the soft sell. He had a creative mind, was a penetrating observer and a superb pragmatist, with the almost uncanny ability to isolate the core of a problem and develop a practical solution.

Armstrong was cut from the same cloth as Jimmy Doolittle, Albert Hegenberger, Oliver Echols, and Albert Stevens. Together they were the perfect medical-engineer team to work on the cutting edge of aviation. In the development tests of the XB-15, Echols established new standards for high- altitude long-range flight. His work made the B-17 an effective fighting machine: Flying Fortress. Doolittle established new single engine speed records and obtained significant high-speed propulsion and aerodynamic data. Hegenberger was the first pilot to fly from the U.S. mainland to Hawaii. Stevens and Anderson were the pilots on the Explorer II balloon flight to 72,000 feet, a world record. Quite obviously, this pioneering young medical officer was in fast company. The flight surgeon matched the pilots step for step and many times he had already developed medical answers to anticipated engineering questions.

He alone provided the medical knowledge and technology recommendations for the construction of the sealed pressure cabin on the Explorer II gondola. He had to be right because Steven's and Anderson's lives depended on the answers. Where these two men were going no human had been before. In addition, Armstrong could not just provide the vital medical knowledge and leave the problem. He was the assigned flight surgeon, on the scene, when Stevens and Anderson took off, ascended into the high heavens and returned. Armstrong, therefore, was a comrade who shared the pilots' triumphs and misfortunes. This happy affair for five years was similar to the inseparable Wright brothers and their five years of intense innovative technology. Death separated the Wrights. War separated Armstrong, Echols, Doolittle, Anderson, and Hegenberger. A few years later, Doolittle and Armstrong served with great distinction in the Eighth Air Force in England. Both were commanders in their respective fields. This author had the privilege to be a small part of their undertaking by serving as a young B-24 Airplane Commander in the Second Air Division of the Eighth Air Force. Flying the strategic combat missions devised by Doolittle and wearing the personal equipment and body armour provided by the Central Medical Establishment under Armstrong.

History shall long remember the accomplishments of Echols, Doolittle, Stevens, Anderson, Hegenberger, and Armstrong. They helped mold the fragile technology of the Wrights into the organized high altitude fighting force of World War II. This monumental endeavor took the combined talents of medicine and engineering. Neither could have done it alone. The right chemistry and perception were at Wright Field in early 1935 when Armstrong met with Echols to discuss Armstrong's future work. Echols, then Chief, Engineering Section, gave Armstrong carte blanche to create his proposed medical program. He also pledged to back the young doctor one hundred percent. The significance of this meeting can only now be realized. It made this country the winner in the air war over Europe. The machines could fly very high, very far, and very fast because of Echols and Doolittle. The aircrews could return day after day to live and fight in this rarified and very cold atmosphere because of Armstrong. The overall result was an awesome high-altitude, long-range, air armada, unmatched anywhere in the world.

This historical discussion of the Air Corps engineering program and a young line doctor can be contrasted with the simultaneous medical history in the Air Corps. It is important to put proper perspective on the medical service which supported Armstrong. In 1917 Major Lyster recommended to the Surgeon General the establishment of a program for physical examinations for all future flyers. Special Order #207 assigned Major Lyster to duty as Chief Surgeon, Aviation Section,Signal Corps. Sixty seven medical examining units were established for screening pilot applicants. A Medical Research Board and Medical Research Laboratory was established. In 1918 the Central Medical Research Laboratory was created at Hazelhurst Field, Mineola, Long Island, New York. The first course of instruction for flight surgeons was organized. It included lectures on applied psychology and human performance by Major John Watson, an original member of the Laboratory staff. The Medical Research Laboratory was then moved to Mitchell Field, Long Island, New York. In 1921 the School for Flight Surgeons burned to the ground. The altitude chamber was not destroyed. It was removed and sent to the Equipment Branch at Wright Field. In 1926 the School of Aviation Medicine was moved to Brooks Field, San Antonio, Texas. In 1931 the School of Aviation Medicine moved to Randolph Field, Texas. The mission of the school was to conduct medical courses for candidate flight surgeons, and establish standard medical examinations for pilot candidates. The graduates of this school were assigned to flying squadrons. At this interface with the squadron pilots the flight surgeon became aware of the massive engineering developments. The few flight surgeons who were really concerned about the flying problems made attempts to help in the improvement of personal equipment. This is exactly the interface that caused Major Grow and independently Captain Armstrong to take action by applying medical knowledge to equipment design. Grow was faced

with the problem at Patterson Field and Armstrong made attempts at problem solution while stationed at Selfridge Field. Grow, the more senior officer, had orders in 1934 transferring him to Washington where he was able to apply stronger arguments for problem solution. With this greater authority and position, Grow served in the role of medical mentor to the young Captain Armstrong. The documented record, however, shows that Captain Armstrong was the individual who used Air Corps management channels to prepare and submit for approval, the basic proposal to organize the Physiological Research Laboratory. This Armstrong proposal was submitted through the engineering channels of the Materiel Division. Major Echols was Chief, Engineering Section at Wright Field. Armstrong had often sought his advice and guidance. Echols became the engineering mentor for Armstrong. It was this dual approach that resulted in the Air Corps approval to establish the Physiological Research Laboratory in 1935.

Army Air Corps historical records indicate that Armstrong's opportunity at Wright Field was a lucky event. The Equipment Branch often called upon the Chief, Medical Branch, at Wright Field for medical assistance. The Medical Branch was assigned to the Administration Section of the Materiel Division. If Captain Reinartz, a graduate Flight Surgeon from the School of Aviation Medicine, had been more interested in the problems of engineering/medicine while he was Chief, Medical Branch, in 1928, he would have been the founder of the Physiological Research Laboratory. In 1931-1934, the same situation applied to Major Reed, who was the Chief, Medical Branch. He provided the entire medical support for the first chamber experiments of the Wiley Post pressure suit. This suit was tested in the Mineola N.Y. chamber which then belonged to the Equipment Branch. Major Reed left his office on the first floor of Building 16 and descended the circular stairway into the basement to serve as medical monitor for the high altitude chamber tests. The suit, with Mr. Wiley Post inside, was pressurized to 5 PSI in those experiments. Published Air Corps letters in August 1934, one month prior to Armstrong's arrival at Wright Field, requested Major Reed's assistance. He responded to those requests with medical support. Major Grow was not contacted for those tests since he was stationed at Patterson Field and was not assigned to the Materiel Division. None of the historical medical literature mentions this major event in aviation history. The engineering/pilot officer requesting this medical assistance was Captain Albert Hegenberger. He won the Collier Trophy for the operational development of blind (instrument) flying. Captain Hegenberger was Chief, Equipment Branch, when the Wiley Post suit was tested. He was still the Branch Chief when Captain Armstrong was first assigned to the Equipment Branch. It is abundantly clear that Captain Armstrong was totally dedicated to the science of aviation medicine and that he pursued this goal with strong determination. Within four years after his arrival at Wright Field, he was awarded the Collier Trophy. No other flight surgeon ever matched his accomplishment. Captain Armstrong became a legend in his own time. HE IS THE DOCUMENTED FOUNDER OF THE PHYSIOLOGICAL RESEARCH LABORATORY.

** AUTHORS NOTE

Classified research programs are not covered in this history book.

Fig 5 The Wright Field complex when Captain Armstrong founded the Physiological Research Laboratory, in May 1935

CHRONOLOGY
ORGANIZATION & COMMAND

1917	McCook Field (Aviation Engineering Division)	
1919	McCook Field (Engineering Division: Aircraft Branch, Equipment Branch, Armament Branch, Engine Branch, Materials Branch)	
1926	ARMY AIR CORPS	
1927	Wright Field Dedicated	
1935	Physiological Research Laboratory	Capt. Armstrong
1939	Aero Medical Research Unit	Capt. Armstrong
1940	Aero Medical Research Unit	Dr. Heim Capt. Benson Jr.
1941	ARMY AIR FORCES	
1942	Aero Medical Research Laboratory	Maj. Benson Jr.
1942	Aero Medical Laboratory	Col. Benson Jr. Col. Lovelace II
1945		Col. Griffis
1946		Col. Kendricks
1947	U. S. AIR FORCE	
1949		Col. Carlson
1951	AIR RESEARCH & DEVELOPMENT COMMAND	Col. Blount
1954		Col. Bollerud
1958		Col. Stapp
1959	Aerospace Medical Laboratory Aerospace Medical Division	Col. Stapp
1960		Col. Karstens
1961	AIR FORCE SYSTEMS COMMAND Aerospace Medical Division 6570th Aerospace Medical Research Laboratories	
1964		Col. Quashnock
1966		Col. Yerg
1968		Col. Kratochvil
1970		Col. Holt

1973		Col. Doppelt
1976		Col. DeHart
1979	AF Aerospace Medical Research Laboratory	
		Col. Mohr
1985	Harry G. Armstrong Aerospace Medical Laboratory	

CHAPTER ONE

EARLY AEROMEDICAL RESEARCH 1934-1940

ORGANIZATION AND COMMAND

Lieutenant Harry G. Armstrong was assigned to duty as Flight Surgeon in the First Pursuit Group, Selfridge Field, Michigan, on September 15, 1931. He regularly flew with the Group in the P-16 aircraft, a two place open cockpit biplane. These flights exposed the aircrew to extremely cold temperatures, windblast, noise, high altitude, vibration and high acceleration forces in combat maneuvers. This flying environment prompted Armstrong to begin a series of efforts to develop better aircrew protective equipment. He quickly encountered local resistance to his activities. Frustrated, Armstrong wrote a letter to Major Beaven, Air Surgeon, Hq. Army Air Corps, in June 1934. He described the flight environment and the resistance to his efforts. He requested assistance from the Air Surgeon and the Engineering Section at Wright Field. Armstrong did not receive a reply to his letter. Instead he was issued orders in July, 1934, transferring him to the Medical Branch at Wright Field. Captain Armstrong, who had no research or development experience, flew to Washington and contacted Major Beaven about the assignment. Major Beaven told him "you are the one that complained and you are the logical man to try and solve it." Captain Armstrong flew to Wright Field in August 1934 to meet the resident medical officers and obtain information about the assignment. He had lunch with Major Grow, Flight Surgeon, Patterson Field, and Major Reed, Chief, Medical Branch, Wright Field. Armstrong had never met or been acquainted with either of these officers prior to this luncheon. A heated argument developed between these two men over the assignment of Captain Armstrong. Shortly after his return to Selfridge Field, Armstrong was advised that his orders had been changed and he was now assigned to the Engineering Section, Equipment Branch.

Captain Harry Armstrong was transferred to the Materiel Division, Engineering Section, Equipment Branch, at Wright Field on September 16, 1934. He was the only medical officer in the entire Engineering Section. When Captain Armstrong reported for duty in the Equipment Branch, Bldg 16, he was treated as a consultant and not assigned to any project. He spent the next few days getting acquainted with the people, programs, and facilities in the Equipment Branch. The Branch was responsible for research, development, and testing of all subsystem equipment used in support of Army Air Corps flight operations. To accomplish its mission, the Branch had available in the basement of Bldg. 16, an extensive machine shop, an engineering group, photo department and a drafting group. To reach these facilities from the first floor of Building 16, there was a circular stairway within the Equipment Branch that descended to the basement. Also located in the the basement was the altitude chamber which had been used previously for training in the School of Aviation Medicine at Mineola, New York. The chamber was in good operating condition. The Equipment Branch used this chamber plus two smaller chambers and a cold box for testing new experimental equipment. When the chamber tests involved human subjects, the Equipment Branch requested a medical officer from the dispensary. Two months before Armstrong's arrival, the chamber had been used to test a full pressure suit designed by the world famous pilot, Wiley Post (E.O. 666-2, Serial No.I-54-431, June 21,1934, Capt. Hagenberger)

For the next few months, Armstrong worked on the problems he encountered at Selfridge Field and the projects assigned by the Chief, Equipment Branch. He was also assigned to work involving the Explorer II sealed gondola being manufactured in Building 16. Captain Armstrong served as the Flight Surgeon for this record breaking balloon flight which attained an altitude of 72,000 feet. Concerned that he might be working on misdirected efforts, he sought guidance

from Major Echols, Chief Engineering Section. Major Echols stated "that he was not a physician and that he felt research in the field of medicine should be Armstrong's responsibility and that he should pursue his own ideas." Echols further said "that if Armstrong got into trouble with his work, that he would back him one hundred percent." Captain Armstrong then prepared and sent to Major Echols a proposal to establish a Physiological Research Laboratory within the Equipment Branch. Major Echols favorably reviewed the proposal and forwarded it through the Materiel Division to Hq. Army Air Corps.

Captain Armstrong flew to Washington on April 16, 1935 and met with Lt/Col Grow, Chief, Medical Division, Office of the Chief, Army Air Corps, and the Army Surgeon General. Captain Armstrong presented the proposal he had submitted to Major Echols. The Armstrong proposal was accepted by those senior medical officers. Their only guidance was to establish a coordinated relationship between the Physiological Research Laboratory and the School of Aviation Medicine to avoid duplication of effort. The Materiel Division, Engineering Section, formally recommended the establishment of a Physiological Research Laboratory on April 25, 1935. The Chief, Army Air Corps, issued a directive on May 29, 1935, establishing the Physiological Research Laboratory within the Equipment Branch.

(Historical Note:) In 1935 there was a rapidly evolving need for a formalized medical research activity at Wright Field. Headquarters, Army Air Corps, had directed the Engineering Section to initiate a sealed pressure cabin airplane development program on April 29, 1935. The Equipment Branch was assigned responsibility for development of the sealed pressure cabin. The Branch was also directed to conduct a comprehensive study of the combined engineering and physiological requirements and to incorporate the data into an engineering specification. The Chief, Equipment Branch, assigned Armstrong the job of providing the physiological data. Armstrong's report, ACTR #4165, dated December 19, 1935, was used in the aircraft specification. A contract was awarded to the Lockheed Corporation in 1936 and the XC-35 aircraft was delivered to Wright Field in the spring 1937. It was a derivative of the commercial Lockheed Electra. Amelia Earhart used this type of aircraft on her ill-fated flight around the world.

The mission of the new Physiological Research Laboratory was established at Langley Field, Virginia, on June 19, 1935.

The approved mission defined three research goals which were necessary for the satisfactory performance of tactical combat flights.

• Physical discomfort • Mental distraction • Fatigue

These goals were further refined into prime technical areas.

- Protection from cold, windblast, heat, oxygen want
- Comfortable seating
- Clear vision
- Reduction of noises
- Avoidance of extreme centrifugal and centripetal forces
- Avoidance of heavy, bulky, or constricting clothing, and personal equipment
- Simplification of airplane operation

The staff of the new Physiological Research Laboratory was Captain Armstrong and Sgt. Lloyd Stevens, a medical technician on loan from the dispensary. The annual budget was $100.00 for supplies and $600.00 for animals. Captain Armstrong flew to Harvard University in an O-25 aircraft on November 30, 1935, to consult with Professor Drinker about laboratory equipment and hiring personnel. Professor Drinker recommended his graduate assistant, Dr. J.W. Heim. After an interview, Captain Armstrong hired Dr. Heim for the position of associate physiologist. He reported on June 21, 1936. Private Ray Whitney was assigned to the Laboratory in November 1937. In the fall of 1938, Sgt. Fuhry was assigned to the Laboratory and two other men, Pvt. Moyer and Pvt. Robinson, were on loan from the Base dispensary. On February 10, 1939, the Equipment Branch was renamed the Equipment Laboratory and the Physiological Research

Laboratory name was changed to the Aero Medical Research Unit. Miss Mae Callen joined the Unit as stenographer in June 1939. Mr. John Hall joined the Unit on September 5, 1939, as assistant physiologist. Dr. Ernest Pinson was hired on September 11, 1939, as an associate research physiologist. Sgt. Harold Lichty was assigned to the Unit in 1940.

Captain Armstrong was reassigned on May 30, 1940, to a course of instruction at the Banting Institute, Toronto, Canada. Dr. J.W. Heim was appointed Acting Chief, Aero Medical Research Unit, on May 30, 1940. Captain Otis Benson, Jr. was appointed Chief, Aero Medical Research Unit, on September 16, 1940.

ARMY AIR CORPS AIRCRAFT

A-17, B-10, XB-15, YB-17, B-18, C-33, O-47
P-26, P-35, P-36, BT-9,PT-13
XC-35 the first successful pressurized aircraft

CHALLENGING AEROMEDICAL PROBLEMS

- Human physiology in high altitude flight
- Acceleration physiology in combat flight maneuvers
- Thermal physiology during cold weather flight
- Development of personal protective equipment
- Development of emergency medical equipment

PIONEERING ACHIEVEMENTS

BEFORE APPROVAL OF PHYSIOLOGICAL RESEARCH LABORATORY

- Design of a small first aid kit for aircraft (October 25, 1934)
- First recommendation on use of a carbon monoxide detector for aircraft (January 2, 1935)
- Study on bone conduction of aircraft sound and vibration during flight (January 31, 1935)

AFTER APPROVAL OF PHYSIOLOGICAL RESEARCH LABORATORY

- National Geographic Balloon flight to 72,000 feet for which Captain Armstrong provided the physiological data for the sealed gondola and served as flight surgeon (November 11, 1935)
- Literature study on the effect of pilot stature on aircraft design and performance (December 11, 1935)
- Literature study on physiological requirements of sealed high altitude aircraft compartments (December 19, 1935)
- Research on the effects of acceleration on the living organism (December 1, 1937)
- First experiments and actual demonstration that body fluids will boil at an altitude of 63,000 ft (March 23, 1939)
- Evolution of the concept of "aero-otitis media," the pathological changes in the middle ear caused by differences in barometric pressure.

PROJECT NUMBER	TITLE
E. O. 653	Clinical Studies
E. O. 656	Aircraft Lighting
E. O. 660	Oxygen Equipment
E. O. 664	Aircraft Equipment
E. O. 666	Protective Equipment
E. O. 903	Administrative

FACILITIES

Office, Captain Armstrong, Miss Callen	Bldg 16
Office, Dr. Heim, Dr. Pinson, Mr. Hall	basement Bldg 16
High Altitude laboratory	basement Bldg 16
Biochemical laboratory	basement Bldg 16
Physiological laboratory	basement Bldg 16
Operating room	basement Bldg 16
Balance room	basement Bldg 16
Stock room	basement Bldg 16
Man-rated centrifuge	Balloon Hanger
Abrupt acceleration swing	Balloon Hanger

THE LABORATORY PROGRAMS

OVERVIEW

The research program was created entirely by Captain Armstrong. It was an integration of the flying experiences at Selfridge Field, the aircraft and missions under development at Wright Field, the personnel, laboratory equipment, and facilities available at Wright Field. There were three fundamental drivers in the program. The first was in the area of high altitude flight physiology. The National Geographic balloon had just flown to an altitude of 72,000 feet, Wiley Post was using his own full pressure suit in high altitude flights, the XC-35 was under development, and there was an urgent need to develop an operational oxygen mask. (During high altitude flight, a pilot received oxygen through a pipe stem he kept in his mouth). Second, was the all metal P-35 fighter which could fly high acceleration combat maneuvers and exhibited a high rate of climb to altitude. Third, was the high altitude extended range test flights of the new XB-15 and XB-19 aircraft. The aircrew were exposed to extreme cold and repeatedly experienced high altitude oxygen conditions for long periods of time.

BEFORE APPROVAL OF PHYSIOLOGICAL RESEARCH LABORATORY

In this period, the only personnel available were Captain Armstrong and one enlisted medical technician. There were neither medical instrumentation nor equipment available to conduct a major research effort. Dr. Armstrong, therefore, was restricted to activities which could be explored and completed using his medical training and entrepreneural spirit for developing aircraft equipment. These studies were primarily in the area of medical safety. They were easy to initiate and dealt with problems of mutual interest to engineers in the Equipment Branch. Some of these studies were also based on the unsatisfactory reports and engineering problems being submitted to the Equipment Branch.

- First design of a small first aid kit for aircraft installation (October 25, 1934)
- First recommendation on use of a carbon monoxide detector for aircraft (January 2, 1935)
- Chief, Equipment Branch, appoints Captain Armstrong as the chairman of a group to study the merits of liquid and gaseous oxygen for use in high altitude flight (January 24, 1935)
- Study on bone conduction of aircraft sound and vibration during flight (January 31, 1935)
- Study on the effect of cold temperatures on the pilot's flying efficiency (March 1, 1935)
- Study on the need for crash tools to remove pilots from wrecked aircraft (March 2, 1935)

AFTER APPROVAL OF PHYSIOLOGICAL RESEARCH LABORATORY OVERVIEW

This period can truly be described as the fundamental start of organized aero medical research. This organization was located at the center of all new aircraft development. Captain Armstrong had been assigned official organization authority, an annual budget, civilian and military personnel positions with approval to hire professional personnel. Dr. J. W. Heim arrived in June 1936 and assisted Armstrong in refining the research program.

These two men now began the task of organizing and equipping the Laboratory with all the necessary scientific apparatus. Captain Armstrong's office was located on the first floor in the Equipment Branch area. The basement facility was 120 feet long and 30 feet wide. They

established floor space for an office, physiological laboratory, biochemical laboratory, and high altitude laboratory. There was also an operating room, balance room and stock room. The various areas were separated by steel and glass partitions and all were completely air conditioned. The office had three desks for Dr. Heim, Dr Pinson, and Mr. Hall. It also contained a library of standard medical books, reference works on aviation medicine and appropriate current periodicals. The physiological laboratory was equipped for research on human subjects and contained all apparatus necessary for the performance of the metabolic and blood gas studies. Complete equipment for air analysis was also located in this area. The biochemical laboratory was provided with all facilities for complete blood analysis and studies of a chemical nature. It contained a chemical table with an acid proof top and a central sink and drain board of chemical stoneware. The table was provided with abundant drawer space and was serviced with direct and alternating current power, compressed air, vacuum gas and water. In addition, the laboratory contained a fume hood, exhaust canopy, the kymograph smoker, the water still, centrifuge, and refrigerator. The balance room was dust proof and contained two high precision analytical balances. The operating room was equipped with the usual facilities including a long paper variable speed kymograph and accessories. It was provided with both direct and indirect lighting which insured ample illumination of the operating field. The large laboratory possessed three high altitude chambers. Two small chambers had a capacity of three cubic feet and were provided with windows which afforded a view of the entire interior. They were surrounded by insulating cabinets of balsa wood and could be refrigerated by means of dry ice. Evacuation was produced either by means of individual hyvac pumps or by connecting the chambers to the main laboratory vacuum system. The altitude could be maintained at any desired value by means of a special manometric control system. The large chamber was of cylindrical construction 31 feet long and 8 feet in diameter, supported in a horizontal position. It was divided into three sections, a central compartment opened on either side into two end compartments. The central compartment thus served as a lock through which entrance from the outside could be made to the other sections without disturbing the pressure conditions in them. The chamber could be evacuated to the equivalent of 80,000 feet and could be refrigerated to -65F.

The Physiological Research Laboratory was ready to undertake its first work in January 1937.

The first effort was a series of animal experiments to gather baseline physiological data on hypoxia, and the effects of explosive decompression associated with sealed cabins flying at high altitudes. The second was a human and animal program to obtain physiological data on the effects of acceleration. While Armstrong and Heim served as the principal investigators, they also participated as subjects. Pvt. Whitney was the technician who accompanied the animals in these high altitude chamber flights. Sgt. Stevens was the centrifuge technician and frequently rode the centrifuge. The Unit began to experience a significant increase in professional personnel in 1939. This growth was associated with the war effort and progressively increased until a considerable staff was assigned to the Unit.

SELECTED PROGRAMS

- Literature study on the effect of pilot stature on aircraft design and performance (December 11, 1935)
- Literature study on physiological requirements of sealed high altitude aircraft compartments. This effort conducted a comprehensive review of all the English and French literature on: high altitude balloon flights, books on respiration and general physiology, medical articles on oxygen-want, oxygen poisoning, CO poisoning, noxious gases, caisson disease, and air conditioning. The information was integrated with the available engineering data for sealed aircraft cabins. The results of this study established the physiological requirements for long range flight while the crew were operating in a sealed cabin environment. This work was incorporated into the Army Air Corps specification for the development of the XC-35 airplane (E O 417-2-358, Report ACTR #4165, December 19, 1935)
- Follow up study on pilot stature as it affected the design and performance of aircraft (February 6, 1936)
- Literature study on the effect of barometric changes on the ear and accessory nasal sinuses (February 8, 1936)
- Study on the effect of flight at high altitude on teeth (August 31, 1936)
- Study to develop equipment for the rescue of injured personnel in crashes in Arctic regions (September 18, 1936)

- Study to develop an Air Corps medical kit for use with flying units. (September 23, 1936)
- Study to develop light weight gas oxygen cylinders, a reliable manually operated gas-oxygen flow regulator and valve and an oxygen mask (September 25, 1936)
- Study and in-flight testing of pilot crash helmets (December 31, 1936)
- Study to devise a test and design the necessary equipment required for a practical test of color blindness in Air Corps pilots (January 16, 1937)
- Study on the factors which influence altitude tolerance in experimental animals. This definitive work exposed one hundred rabbits in the altitude chamber to 1000 feet per minute rate of climb and an average altitude of 33,500 feet with a maximum altitude of 41,000 feet (July 15, 1937)
- Study to determine the absorption rate of CO into the blood at high altitude. Goats were exposed to an altitude of 13,465 feet for a period of ten minutes. Clinical techniques determined the quantity of CO in the blood and tissue (October 28, 1937)
- Study on the effect of acceleration on the living organism was a highly organized study using humans and goats to gather baseline data on human tolerance in the positive, negative and transverse acceleration positions. An instrumented PT-13 airplane was used for the in flight experiments. A twenty foot centrifuge was constructed with a variable speed drive and a twenty five horsepower electric motor. It was equipped with an adjustable seat for human subjects and an adjustable board for the animal experiments. The centrifuge had a maximum velocity of 80 RPM and could produce an acceleration of 20 G. A second piece of equipment was developed for creating high linear accelerations for short periods. The abrupt acceleration swing was suspended from the ceiling by four 40 foot cables and was equipped with a seat for human subjects and a board for animal experiments. It used a brake controlled windlass which could produce an acceleration of 16 G with a duration of 0.5 seconds. These experiments produced baseline information on the physiology of acceleration. Preliminary tests were also conducted on the use of an air inflatable belt to increase the pilots tolerance to positive accelerations. It is interesting to note that one recommendation suggested the pilot be placed in the prone position if the aircraft is designed to exceed 9G in flight (EO 664-1-250, Report #4362, December 1, 1937)
- Study on the effect of repeated exposures to anoxemia on the adrenal glands and metabolic processes of experimental animals (January 15, 1938)
- Study to determine whether or not the decrease of barometric pressure at high altitude will cause nitrogen bubbles to be formed in the blood (February 24, 1938)
- Study on the effect of repeated exposures to high altitude in relation to the function of the adrenal glands. The results of this animal study prompted the recommendation that pilots continually use oxygen on all flights above 12,000 feet (E O 653-1-27, February 18, 1939)
- First experiments and actual demonstration that body fluids will boil at an altitude of 63,000 ft. Using animals, a special viewing tube was surgically inserted in the artery. The animal was then placed in the altitude chamber and exposed to very high altitudes (March 23, 1939)
- Study on the causes and possible prevention of airsickness (July 31, 1940)

This comprehensive research program evolved the concept (aero-otitis media), and a new medical disease entity (aero-embolism). Other work established the physiological limits of breathing pure oxygen in unpressured high altitude flight, the pathology of altitude sickness (anoxia), and the significance of the rate of ascent, duration and frequency of exposure to high altitude flight.

The Aero Medical Research Unit published over thirty technical papers. Using these papers and other references, Armstrong published a book PRINCIPLES AND PRACTICE OF AVIATION MEDICINE in 1939. It was the first inclusive text covering all the complex and diversified medical problems encountered in modern flight. This broad and comprehensive technical program fully established the Aero Medical Research Unit at Wright Field as the major aeromedical center in the United States.

AWARDS

1936	Capt. Armstrong	Welcome Award and prize in Military medicine
1940	Pfc. Whitney	Distinguished Flying Cross
1940	Capt. Armstrong Dr. Boothby Dr. Lovelace	Collier Trophy for high altitude physiology research

Fig I-1 Captain Harry Armstrong, Flight Surgeon First Pursuit Group. Selfridge Field Michigan, 1931-1934

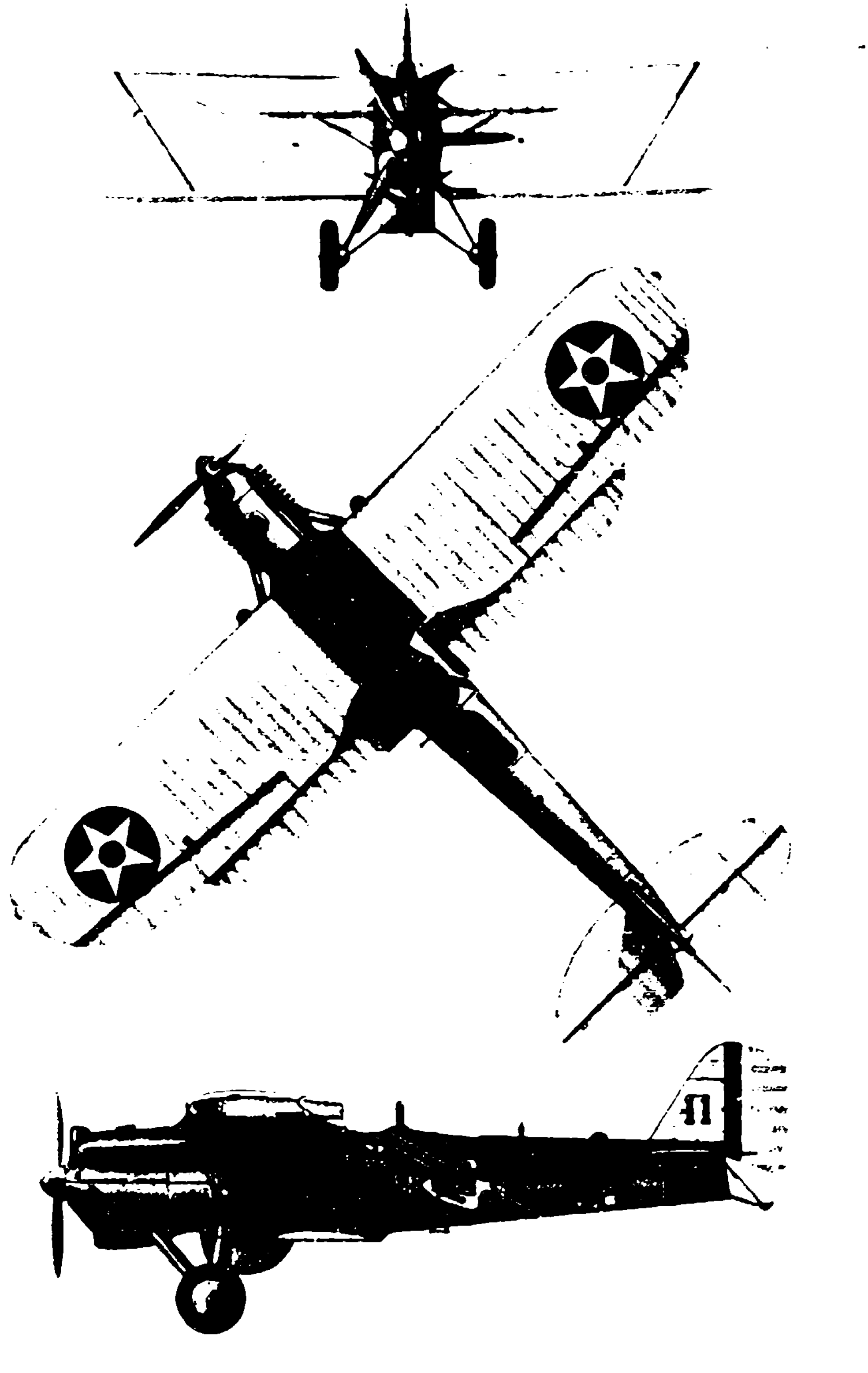


Fig I-2 Flights in this P-16 airplane began Armstrongs attempts to improve pilot personal equipment—First Pursuit Group, Selfridge Field Michigan, 1931-1934

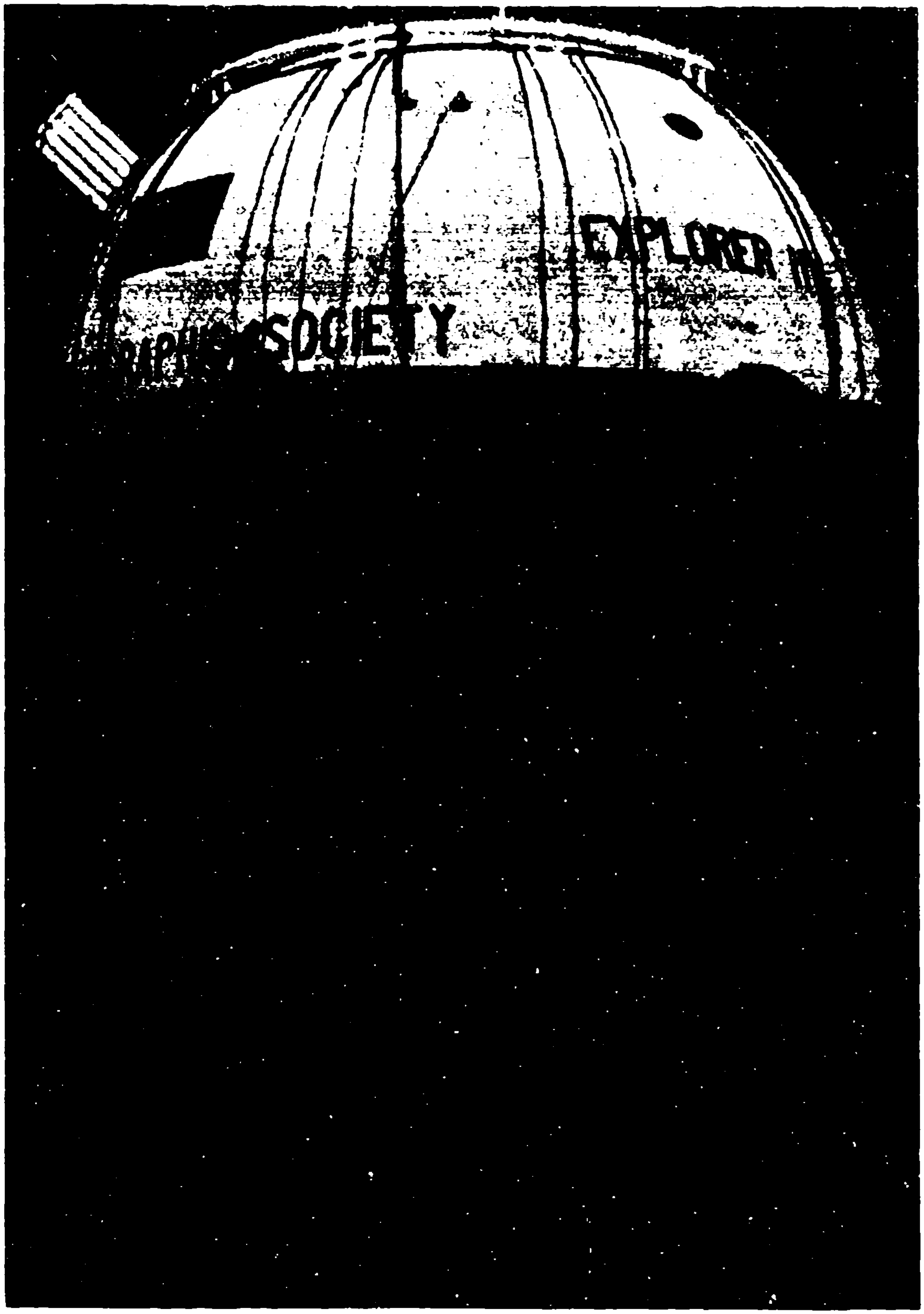


Fig I-3 Captain Stevens and Captain Anderson set the world altitude record in Explorer II on November 11, 1935. Captain Armstrong specified the pressurized closed cabin atmosphere and served as flight surgeon.

Fig 1-4 XC-35, first successful pressurized sealed cabin aircraft. Armstrong specified the physiological requirements for the cabin atmosphere. The cabin pressurization system was manually controlled by Armstrong or Pvt. Whitney on each test flight.

Fig 1-5 Captain Armstrong flew to Boston in this O-25 aircraft to hire Dr. John Heim in 1935

Fig 1-6 Dr. Ernest Pinson and Mr. John Hall in the basement office, Aero Medical Research Unit (Bldg 16, 1939)

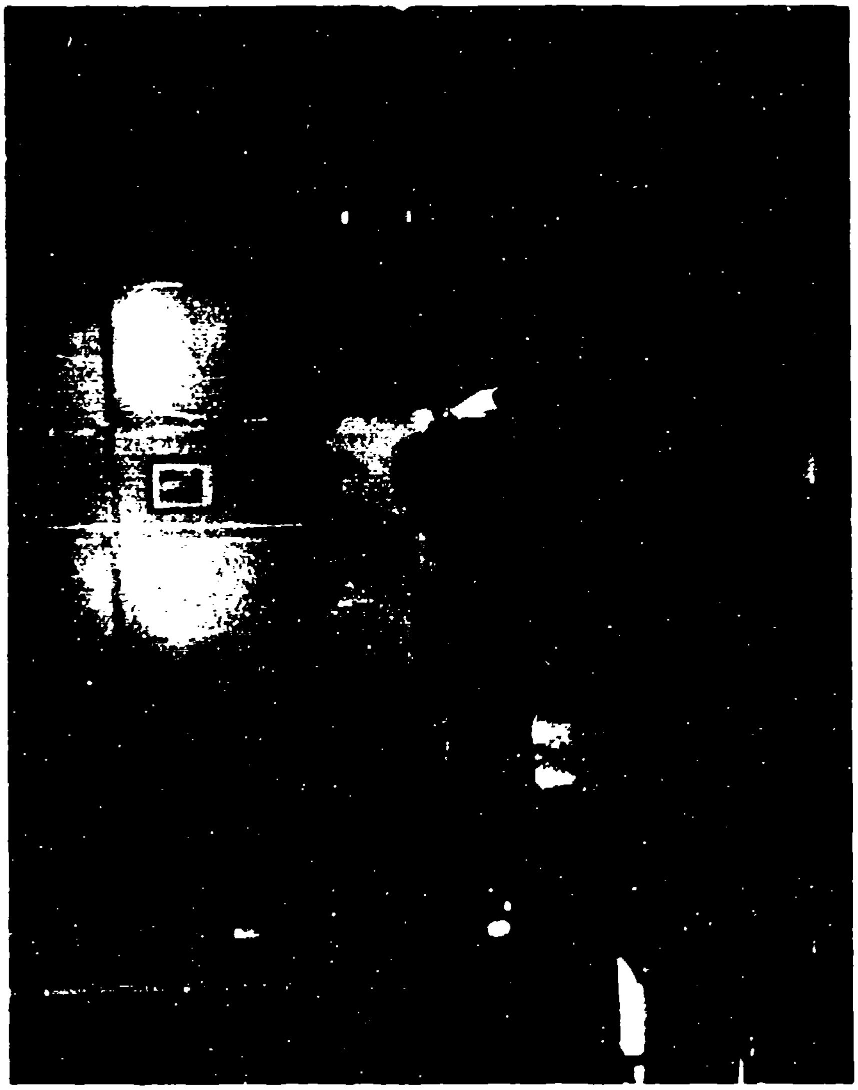


Fig I-7 Dr. Armstrong and Dr. Heim in the main office Aero Medical Research Unit (Bldg 16, 1939)

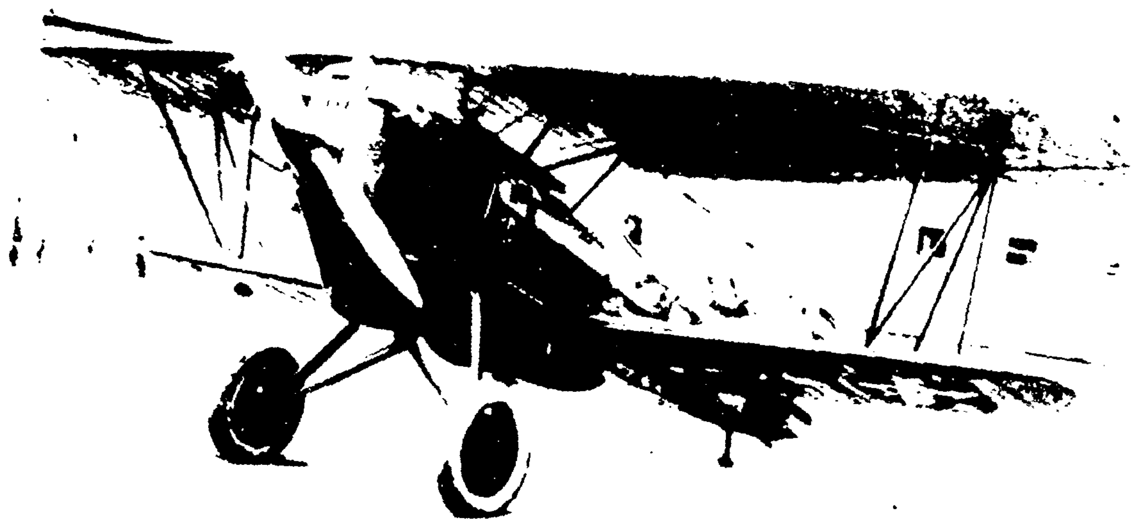


Fig I-8 Curtiss P-5 high altitude fighter. The first supercharged aircraft to enter operational service. This new era of regular high altitude flight required more physiological research on frequent and repeated exposure to low oxygen environments.

Fig I-9 Boeing P-26 fighter. The open cockpit created many physiological problems for the pilot.

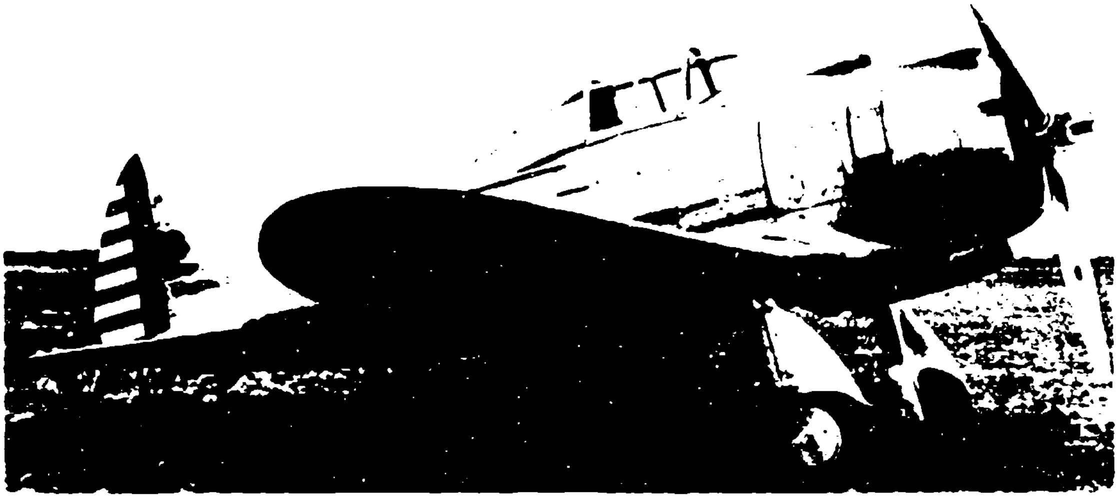


Fig 1-10 Seversky P-35 fighter. Its high performance required studies in human tolerance to acceleration.

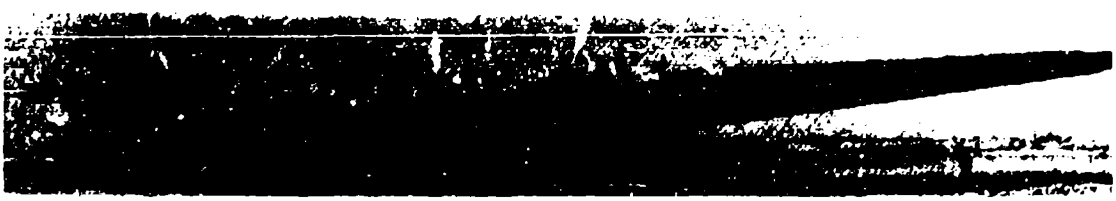


Fig 1-11 Boeing XB-15 bomber. The fore runner of the B-17. This airplane prompted the work on high altitude oxygen masks and long term exposure to oxygen conditions.

Fig 1-12 Second low pressure chamber located at Medical Research Laboratory, Hazelhurst Field, N.Y. The chamber was 10 feet high and 9 feet diameter. When the School of Aviation Medicine was moved to Brooks Field, Texas in June 1926, this chamber was declared surplus. It was relocated to the Equipment Branch, basement Bldg 16 at Wright Field, Ohio.

Fig I-13 Wiley Post in his second pressure suit in the altitude chamber basement Bldg 16, 1934.

Fig I-14 Wiley Post in his third pressure suit in the altitude chamber basement Bldg 16, 1935.

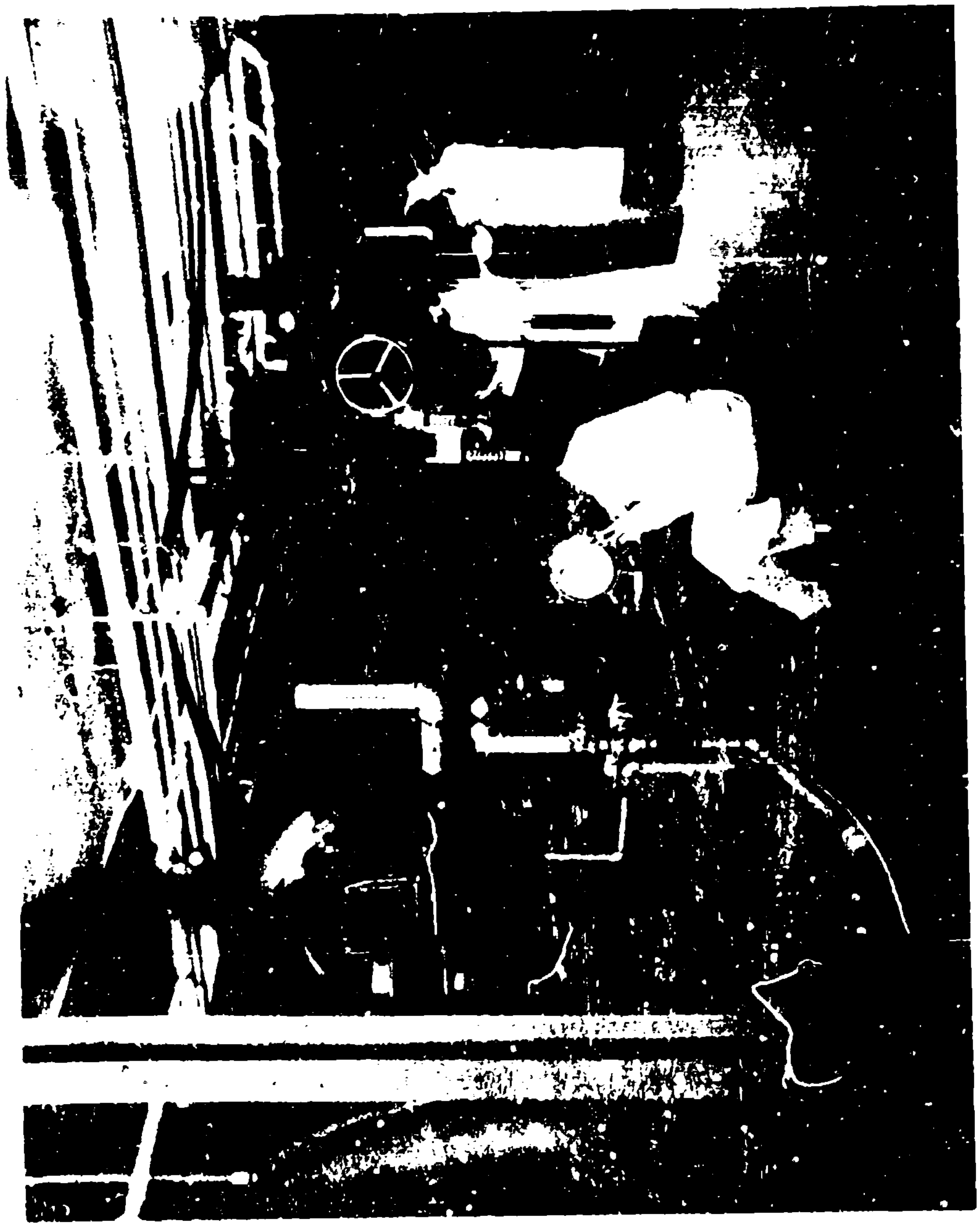


Fig 1-15 New altitude chamber in the Physiological Research Laboratory, basement Bldg 16, 1937.
Dr. Armstrong, S/Sgt Stevens, Dr. Heim

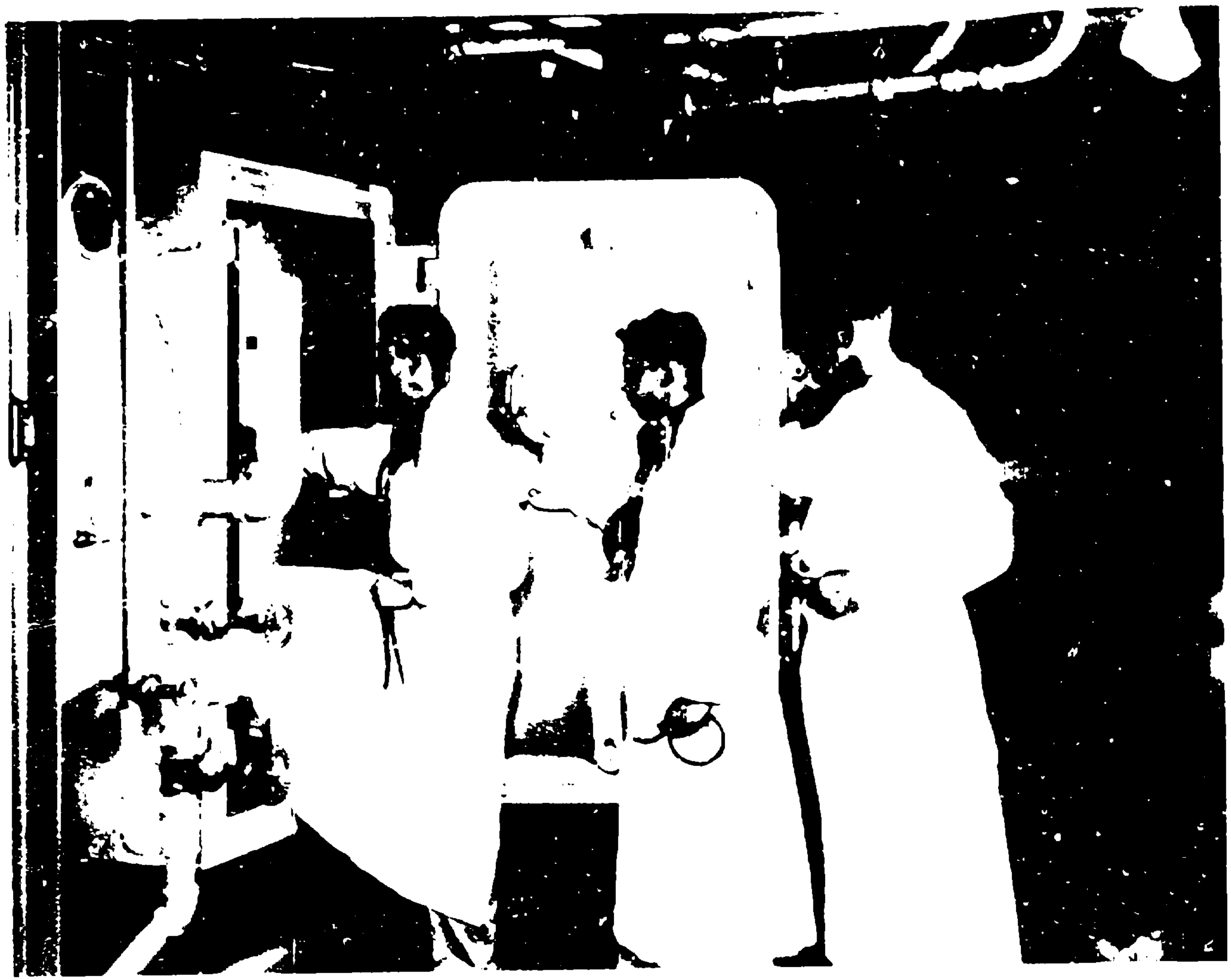


Fig 1-16   Pvt. Whitney, Sgt. Fuhry, Dr. Armstrong altitude chamber basement Bldg 16, 1939.

Fig 1-17 Pvt. Raymond Whitney wearing the BOB oxygen mask in the altitude chamber basement Bldg 16, 1939.

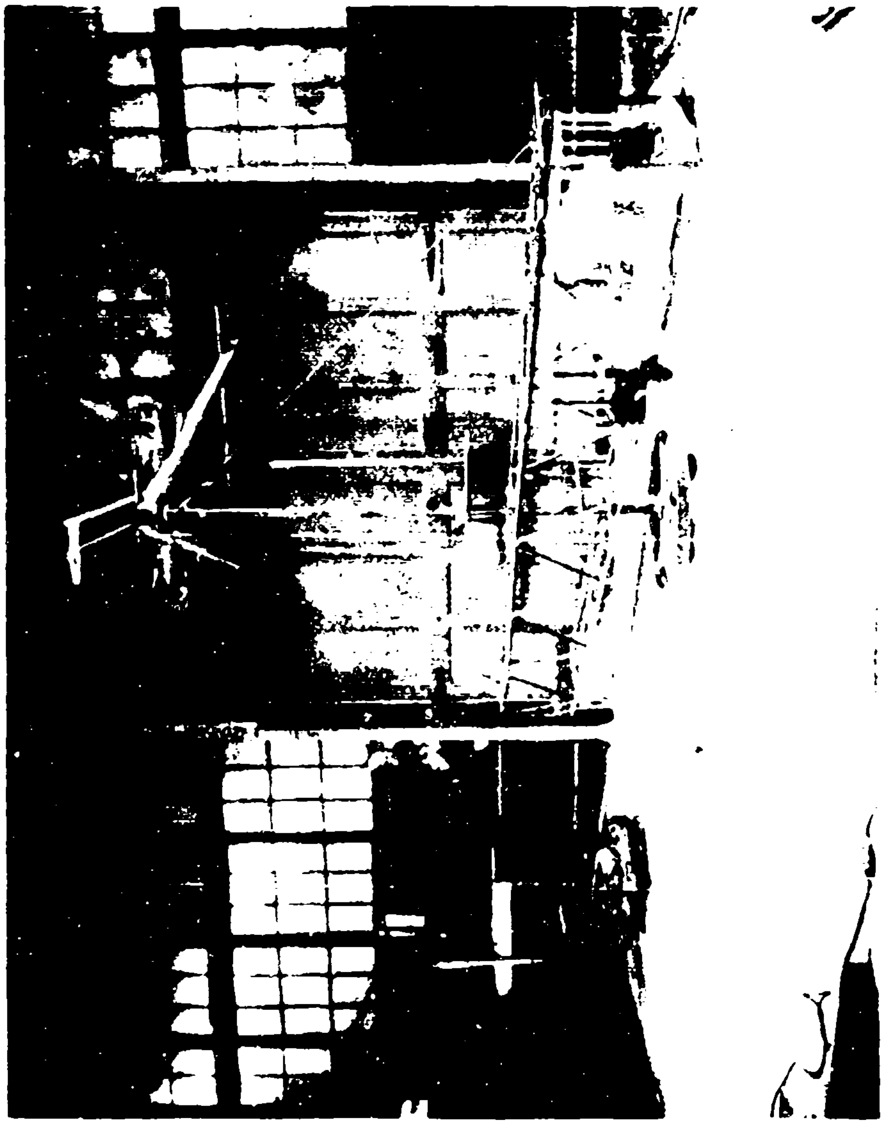


Fig 1-18 First human centrifuge at Wright Field. It was designed by Captain Armstrong and was located in the Balloon Hanger, 1936.

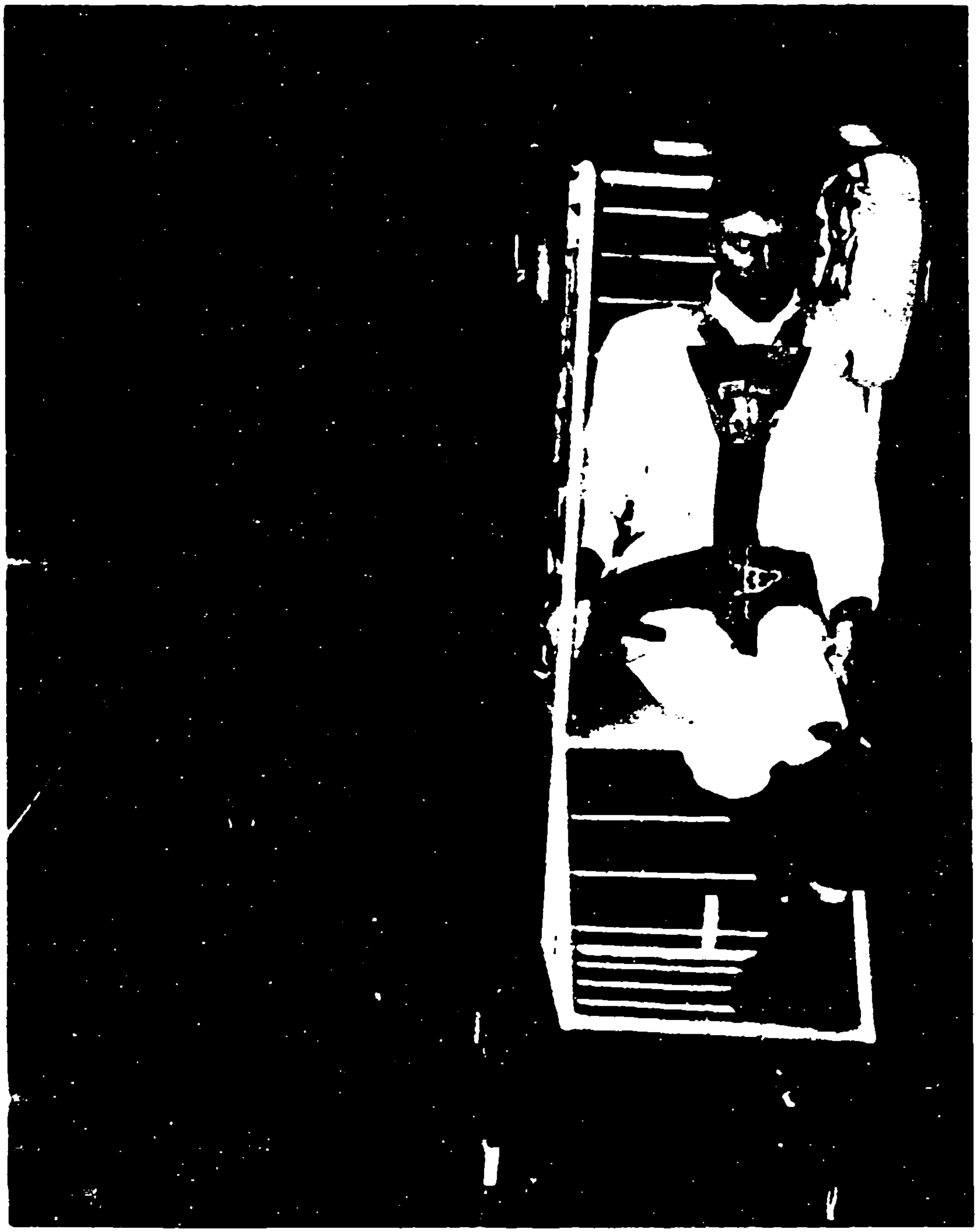


Fig I-19 S/Sgt. Stevens serving as subject on the first human centrifuge.

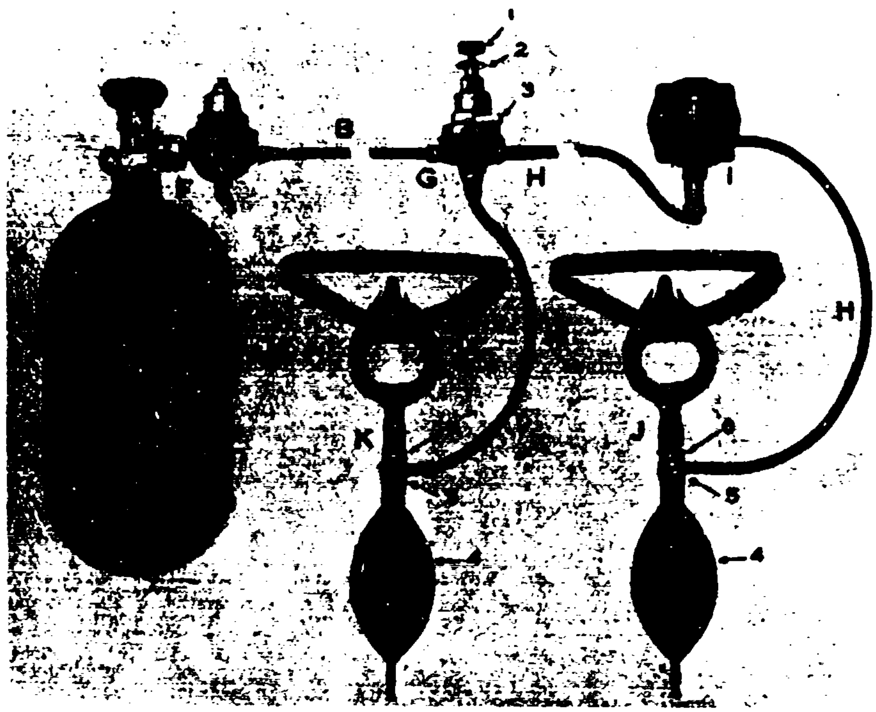


Fig I-20 The BOB oxygen mask. The first successful delivery system for high altitude flight. (Boothby, Lovelace, Armstrong, 1938)

Fig I-21 The team of Boothby, Lovelace, Armstrong receiving the Collier Trophy from President Roosevelt at the White House, 1940.

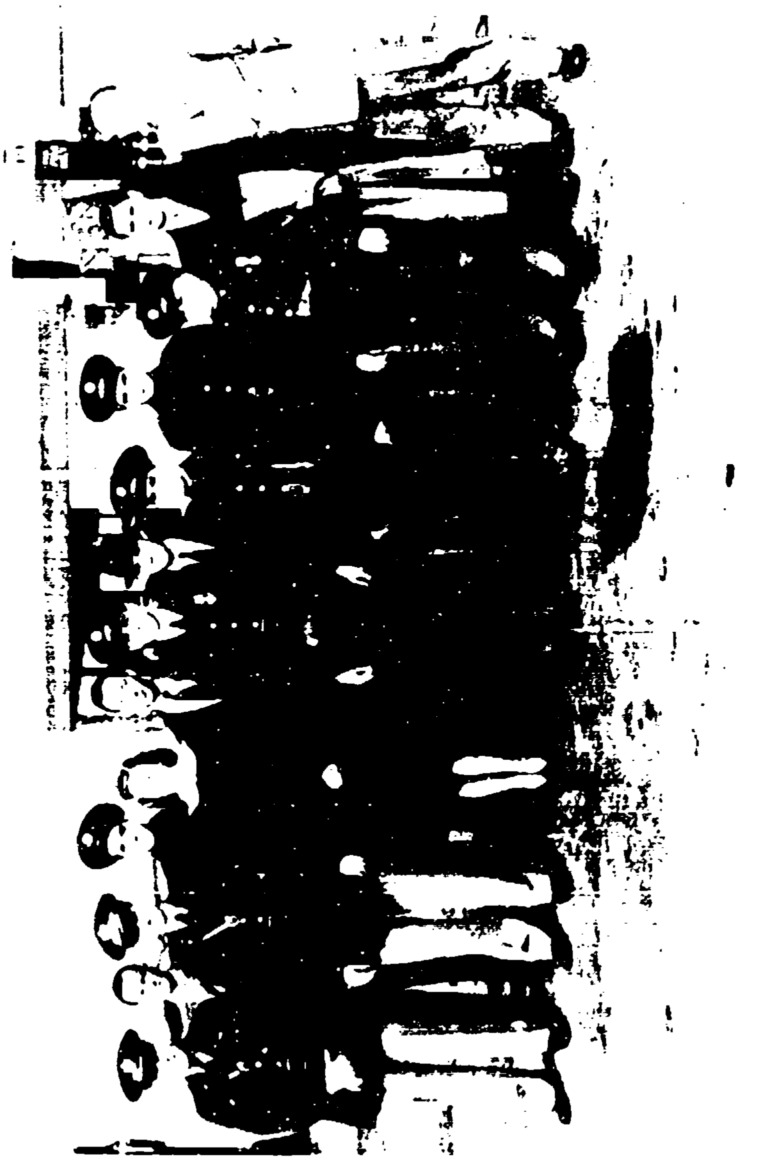


*Fig 1-22 Aero Medical Research Unit, Wright Field (September 24, 1940)
Major Cummings, Mr. Jaffee, Captain Benson, Unknown, Miss Mae Callen, Dr. Hickam, Pfc. Whitney, Mr. Hall, Pvt. Roberts, Pvt. Gross, Cpl. Trout, Dr. Pinson, Dr. Heim*

CHAPTER TWO

THE WAR YEARS 1941-1945

ORGANIZATION AND COMMAND

The Aero Medical Research Unit experienced the same rapid expansion as other organizations in the Army Air Forces during 1941. Captain Otis Benson was Chief, Aero Medical Research Unit. Major Dill, assigned as Chief of Research. Dr. J. W. Heim, Chief, Personnel and Administration.

The Aero Medical Research Unit was removed from the Equipment Laboratory on July 1, 1942. It was reorganized as an independent laboratory and renamed the Aero Medical Research Laboratory. Major Otis Benson was Chief of the Laboratory. The new laboratory was divided into five Branches: Dr. J. W. Heim, Chief, Administrative Branch; Captain John Murphy, Chief, Funds, Property, Maintenance Branch; Major Dill, Chief, Physiology Branch; Major Randy Lovelace II, Chief, Service Liaison Branch; Major Adolph Gagge, Chief, Biophysics Branch. Captain Frank G. Hall, Chief, Chamber Unit in the Physiology Branch. Lt. Francis Randall, Chief, Anthropology Unit in the Biophysics Branch. Dr. Guillemin, Chief, Physics Unit in the Biophysics Branch. Lt/Col. Craig Taylor, Chief, Clothing Test Unit in the Biophysics Branch.

The following mission was assigned to the Laboratory:

- To conduct research to determine the effect of flight on the human organism and to recommend methods or means of neutralizing or eliminating those effects of a deleterious nature which adversely influence the efficiency, health, or safety of flying personnel
- To coordinate the activities of the Laboratory with service and nonservice organizations engaged in similar investigational problems
- To coordinate the human requirements of flight with the development of equipment by other Laboratories in the Materiel Center
- To conduct research on the problems in biophysics, physics, and engineering of importance in aviation medicine
- To initiate and supervise service and field tests of items of medical interest
- To develop standardized and test items of medical equipment used in connection with military flying
- To develop educational devices for indoctrination of flying personnel.
  (Engineering Section Office Memo 42-2A, July 1942)

The Aero Medical Research Laboratory was renamed Aero Medical Laboratory in December 1942. Lt. George Maison was appointed Chief, Centrifuge Unit in the Physiological Branch, on December 11, 1942. Colonel Otis Benson was reassigned overseas and Colonel W. Randolph Lovelace was appointed Chief, Aero Medical Laboratory, in April 1943.

The Equipment Laboratory transferred responsibility for research and development on oxygen equipment to the Aero Medical Laboratory on April 5, 1943. Captain Loran Carlson was appointed Chief, Oxygen Branch, in May 1943. The Laboratory was reorganized into seven branches in September 1943. Colonel Randy Lovelace, Chief, Aero Medical Research Laboratory; Dr. J. W. Heim, Chief, Administration Branch; Captain John Murphy, Chief, Medical Detachment Branch; Major Carl Johnson, Chief, Medical Specialty Branch; Captain Loran Carlson, Chief, Oxygen Branch; Major Adolph Gagge, Chief, Biophysics Branch; Lt/Col. Frank

G. Hall, Chief, Physiology Branch; Captain Doyce Clark, Chief, Service Liaison Branch. At this time the Laboratory had assigned 46 officers, 82 enlisted men, and 73 civilians.

The responsibility for research and development of goggles, sun glasses, and eye protection equipment was transferred to the Laboratory on May 30, 1944. The Hydroponics Unit was established on January 1, 1945.

Establishment of a new Psychology Branch was approved on May 29, 1945. Lt/Colonel Paul M. Fitts was assigned as Chief, Psychology Branch, when he reported for duty in August 1945. The initial staff members were Major Walter F. Grether, Dr. William Jenkins, and Miss Patricia Wall.

Colonel W. Randolph Lovelace departed the Laboratory in September 1945. Colonel Lloyd Griffis was appointed Chief of the Laboratory in October, 1945.

ARMY AIR FORCES AIRCRAFT

P-36,P-38,P-39,P-40,P-47,P-51,XP-55,XP-59,YP-60,P-61,P-70,XP-79,XP-80,XP-82,XP-84,B-17, B-18,XB-19,B-24,B-25, B-26,B-29,B-32,XB-35,XB-36,XB-43,XB-46,XB-48,A-20,A-26,XA-43, PT-17,PT-19,PT-23,BT-13,AT-6,AT-7,AT-9,AT-10,AT-11, UC-64,UC-78,C-45,C-46,C-47,C-54, XC-74,XC-97,SC-99,L-1,L-5
YR-5,XF-12,XR-10

First flight of P-59 jet aircraft at Muroc Air Field (October 2, 1942)

CHALLENGING AEROMEDICAL PROBLEMS

- Developing the first anthropological data base on aircrews
- Anthropology sizing of personnel equipment, flight clothing and aircraft workstations
- Defining the physiological tolerance to prolonged cold temperatures in high altitude flight
- Establishment of thermal protection requirements of protective flying clothing
- Development and standardization of the anti-G suit/valve system for acceleration protection during air combat
- Establishment of human tolerance to high altitude bailout; descent oxygen, descent frostbite, and parachute opening forces at altitude
- Development of air borne oxygen equipment; including oxygen masks, bail out oxygen bottle, low pressure aircraft oxygen system for multicrew long range flight
- Developing the first pressure breathing equipment for long term high altitude flight
- Defining the physiological limitations of explosive decompression for the AAF standard on engineering design of aircraft sealed cabins
- Development of airborne medical evacuation facilities, supplies, and related equipment for the transport of wounded
- Establish human tolerances to ejection escape and windblast

PIONEERING ACHIEVEMENTS

- Established the first physiological training programs for aviators (1941)
- Prepared the first military service manuals concerning the high altitude health hazards to aircrew, PHYSIOLOGY OF FLIGHT (1941)
- First chamber flight of pressure breathing equipment up to altitudes of 43,000 feet (Capt. Gagge, 1941)
- First anthropometric data base on aircrews (Dr. Damon, Dr. Randall, Dr. Brues, Miss King, 1942)

- Initiation of thermal studies for development of aircrew clothing; tropical, arctic (Capt. Gagge, 1942)
- Development of the first AAF pressure breathing mask (Lt. Randall, 1942)
- First aircraft flight using pressure breathing equipment at 42,000 feet (Lt/Col. Lovelace, 1942)
- Development of the first aerosol bomb for the dispersal of insecticides (Lt. Sullivan, 1942)
- First simulated parachute descent in chamber from 45,000 feet using pressure breathing equipment (1943)
- First experiments to establish AAF aircraft design standards for explosive decompression (Major Sweeney, 1943)
- First high altitude bailout with parachute deployment above 40,000 feet (Lt/Col. Lovelace, 1943)
- First human pick-up system (Capt. Maison, Lt. Martin, September 5, 1943)
- First AAF service test and flight tests of anti-G devices, AOS suit and GPS suit at Eglin Field, Flordia. (Capt. Maison, 1943)
- First operational use of F-2 electrically heated flying suit. (Lt/Col. Taylor, 1943)
- Pressure breathing equipment accepted for AAF operational use in 28th Photo Sqdn. (1943)
- First measurements of parachute opening forces in dummy drops from a B-17 at Muroc Army Air Field, California. (Major Hallenbeck, 1944)
- First operational combat mission using pressure breathing equipment in Europe (1944)
- Studies of flyers' night vision, the establishment of vision standards for aircrew, and the development of flying goggles and other vision aids (Captain Pinson, 1944)
- Development of first automatic parachute opening device (Major Hallenbeck, Lt. Martin, 1944)
- First AAF standardization of G-3 suit/valve system (1944)
- Development of the pneumatic balance resuscitator (Mr. Burns, 1945)
- First American tests of the upward ejection seat using human subjects and the 30 foot test facility (Major Savely, 1945)

PROJECT NUMBERS	TITLES
E. O. 689	Development of Anti-G devices
E. O. 695	Human Tolerance to Acceleration
E. O. 666	Personal and Protective Clothing
E. O. 696	Physiological Research
E. O. 660	Oxygen Equipment
E. O. 670	Survival Equipment
E. O. [illegible]	Eye Protective Equipment
E. O. 698	Survival Medical Equipment

FACILITIES

Office, Captain Benson, Miss Mae Callen	Bldg 16
Office, Dr. Heim, Mr. Hall, Dr. Pinson	Bldg 16
Altitude/cold chamber	Bldg 16
Animal operating room	Bldg 16
Biochemical Laboratory	Bldg 16
Animal holding room	Bldg 16
Gas analysis room	Bldg 16
First Human Centrifuge	Balloon Hanger
Abrupt accelerator swing	Balloon Hanger
Construction contract (March 1942)	Bldg [illegible]

Move to Bldgs 29 and 55 (January 1, 1943)	
Construction (November 1943)	Bldg 196, 197, 198
Laboratory Chief	Bldg 29
Laboratory Administration	Bldg 29
Physiology Branch	Bldg 29
Biophysics Branch	Bldg 29
Clinical Research Branch	Bldg 29
Psychology Branch	Bldg 29
Altitude/cold chambers	Bldg 29
All weather room	Bldg 29
Copper mannequin test room	Bldg 29
Vision test facility	Bldg 29
AMRL library	Bldg 29
Vivarium	Bldg 29A
Second Human Centrifuge	Bldg 55
Oxygen Branch	Bldg 196
Oxygen equipment test facility	Bldg 197
Altitude chamber	Bldg 197
Laboratory supply	Bldg 198
Machine shop, wood shop	Bldg 198
Ejection test tower (30 foot)	

THE LABORATORY PROGRAMS

OVERVIEW

World War II developed the first use of military airpower as both a strategic offensive weapon and a defensive weapon. It also evolved the high altitude massive air armada concept which delivered tremendous destruction on any known target. There were many bombing missions which involved more than one thousand bomber aircraft plus another five hundred supporting fighters and reconnaissance airplanes. That type of air combat logistics, at 30,000 feet in a winter sky over Europe, placed significant pressure on aero medical research to provide the technology for human performance and protection. The research programs in the Laboratory during those four years fully reflect the combat needs of the aircrews. History completely documents the heroic efforts of the scientists in this Laboratory. A review of the combat equipment available to the front line aircrews shows that it started in the five little white buildings situated on the side of the hill just below the monument to the Wright Brothers. The most significant fact about that life support equipment was that it flowed from Wright Field to the Central Medical Establishment (CME) in the Eighth Air Force. The Commander of the CME, in 1944, was that very same young entrepreneur doctor who started it all in 1935. Colonel Harry Armstrong and his gang were back together once again. A direct pipeline across the ocean. Armstrong's ten years of leadership were now keeping the aircrews on the front line of aerial combat using pressure demand oxygen systems, electric flying suits, aircrew armour, high altitude flight clothing, anti-G suits, and anthropometric sizing of aircraft equipment.

SELECTED PROGRAMS

In 1940, there were shortages in some sizes of flying clothing and surpluses in others. Many aircraft escape hatches were too small for safe use, and gun turrets imposed a limitation on the size of gunners. The Army Air Forces had inadequate body data on the highly selected population of flyers. Captain Otis Benson invited Dr. Ernest A Hooton, professor of anthropology at Harvard University, to visit Wright Field. They inspected American and British gun turrets and reviewed the flight clothing tariff schedules. This meeting established the immediate need for an anthropological survey and the development of new body dimension data for aircraft designers. The major anthropological surveys were body size survey, clothing survey, somatotypes, and facial surveys ranging from aviation cadets to women flyers. Lt. Damon and Lt. Randall conducted the anthropological surveys. They were assisted by Dr. Brues, Miss Alice

King and others. The first results were used to adjust body dimensions on gun turrets in B-17, B-24, and B-25 aircraft. A year later Captain Randall also used the data in a major research program to design the first AAF pressure breathing mask. The survey data also impacted development of anti-G suits, high altitude flight clothing, oxygen masks, the sizing of aircraft equipment and the layout of aircraft workstations. A series of technical reports prepared in design standard format were published and distributed to the aircraft industry (Lt. Damon, Lt. Randall, E. O. 653-92, February 21, 1942).

Fundamental research on acceleration physiology was conducted by the Acceleration Section. There was a research program using the manrated centrifuge in the Mayo Clinic and the Air Force's new centrifuge which became operational in May 1943. These two facilities established the unprotected and protected human tolerance to long term acceleration in the +Gz,DGz,+Gx,DGx directions. Human tolerance to acceleration onset rates were also determined. This information was obtained by highly specialized physiological experiments using volunteers. These extremely dedicated and very brave scientists underwent life threatening experiments to fully comprehend the physiological factors while exposed to acceleration forces. The physiology data from these experiments indicated that it was possible to design and develop an anti-G suit to protect the pilot. This information was integrated with the pioneering work of Captain Poppin (USN) and Dr. Wood (Mayo Clinic) to establish the fundamental base for development of the AAF standard G-3 suit/valve. The Wood/Clark AOS suit and the Navy GPS suit were service tested at Eglin Field in September 1943. The GPS suit was selected as the technical direction for further development. Improvements in the GPS suit produced the G-1 suit. Captain Maison delivered twenty two G-1 suits to operational units in Europe for noncombat tests in December 1943. The results of these tests suggested improvement which resulted in the G-2 suit and the G-3 suit. The Army Air Force standardized the G-3 suit in November 1944. The Laboratory then sent Lt. Ernest Martin and his assistant, Lt. Ken Penrod, to England in 1944 with a quantity of G-3 suits/valves. He supervised Eighth and Ninth Air Force personnel in England and France on the installation of this equipment in the P-51 and other fighter aircraft. In addition, Lt. Martin instructed the aircrews in the use of this new equipment (Capt. Maison, Lt. Martin E. O. 696-37, 1942-1945)

The Aero Medical Laboratory in association with the Equipment Laboratory initiated a research program to demonstrate that a human could be successfully picked up from the ground by an aircraft traveling at an indicated airspeed of 130 MPH. The objective of this work was to retrieve a man from behind enemy lines after he had been dropped there to perform intelligence or sabotage work. The equipment design was established by Laboratory data and testing. Initial field tests were conducted with a Stinson XC181D aircraft, using sheep as human analogs. The first human pickup, Lt. Alexis Goster, was accomplished at Wilmington, Ohio on September 5, 1943 (Captain Maison, Lt. Martin. E. O. 696-53, 1943)

Major Henry Sweeney directed a program on explosive decompression to establish the first Army Air Forces requirements for the pressurization of fighter and bomber aircraft. A P-38 cockpit mock-up was installed in the Laboratory's altitude chamber facility. The mock-up had interchangeable metal plates with openings of various sizes, which simulated the gun fire holes encountered in combat. These holes were covered with paper which could be ruptured in the chamber to produce an explosive decompression in the cockpit mock-up. Using human subjects equipped with standard oxygen equipment, the size of the opening, the pressure differential, and the altitude were increased. Complete medical evaluations were conducted on each subject after a test. The fighter aircraft tests were conducted at 45,000 feet using 2.75 PSI and an opening of 18 square inches. The bomber aircraft tests were at 35,000 feet using 66 square inch opening, 6.55 PSI and a one thousand cubic foot cabin volume. One hundred fifty explosive decompression tests were conducted. Twenty percent of the subjects suffered the bends during the ensuing five minutes. These tests established the safe pressure differential at 7.5 PSI for combat aircraft (Major Sweeney, E. O. 696 May 1943)

The Laboratory studied the serious limitations of the demand oxygen system when flying at very high altitudes. Captain Gagge's work showed that the only way to keep blood oxygen saturation above 85%, when flying at altitudes in excess of 41,000 feet, was to increase the oxygen pressure in the lungs. Captain Gagge, wearing the prototype pressure breathing equipment, made the first chamber experiment to an altitude of 43,000 feet on December 12, 1941. He began a two year development program using human subjects and the Laboratory altitude chamber. The new pressure breathing mask was designed by Captain Randall,

Anthropology Unit, Biophysics Branch. The compensated exhalation valve was designed by William Wildbock. The initial pressure breathing regulator was designed by the Emerson Company, and modified by Pioneer Instruments. The pressure breathing equipment delivered pure oxygen at pressures of 15 to 25 mm Hg above the ambient pressure. Lt/Col. Lovelace made the first aircraft flight with pressure breathing equipment in a B-17 to an altitude of 42,000 feet in November 1942. He made another flight in a P-38 to 44,980 feet in April 1943. The pressure breathing equipment was procured and delivered to the operational combat units where it was first used by the 28th Photo Sqdn on October 26, 1943. In November, 1944, it was used in high altitude flights over Tokyo (Capt. Gagge, E. O. 696, 1942-1944)

B-17, B-24, and B-29 aircraft flew combat missions at altitudes in excess of 30,000 feet to minimize enemy flack. These combat flights significantly increased the frequency of high altitude bailouts. Combat reports received in the Laboratory, from the Eighth Air Force, described many hazards and injuries associated with these parachute jumps. A comprehensive technical review of these combat reports showed that descent from high altitude with an open parachute created the hazards of anoxia, frost bite, increased parachute opening shock, loss of personal equipment, gloves, boots, flying goggles, and emergency bailout oxygen, and vulnerability to gun fire during descent. These dangers made free fall descent a more desirable alternative to immediate parachute inflation The free fall descent, however, presented the following hazards: failure to pull the ripcord due to spinning accelerations, combat wounds or a frozen parachute pin flap, hemorrhage, or anoxia. The results of this technical review indicated that several research programs were needed to solve the emergency bailout problem. The major research efforts; (1)conduct a study on the materials and physics of parachute design, (2)conduct instrumented high altitude tests using the 24 foot and 28 foot parachute to measure the opening acceleration forces, (3)improve the design of emergency bailout oxygen equipment, (4)develop an automatic parachute opening device, (5)establish the physiological time relationship of frost bite during free fall descent, (6)redesign the personal equipment to prevent loss during high opening shock or free fall spinning. To obtain first hand data on these problems, Lt/Col. Lovelace, Chief, Aero Medical Laboratory, made a static line opening parachute jump from 40,200 feet at Ephrata, Washington, in June 1943. He used AAF standard personal equipment issued to the bomber crews. Upon landing he was found to be suffering from severe shock, frost bitten hands and limbs. The jump verified the information on parachute opening shock, frost bite, and personal equipment loss which had been received from the combat units. This jump established a world altitude record for parachute descent.

Precise technical data on parachute opening forces at high altitudes was not available in 1943. An experimental program to collect this information was initiated in a joint activity between the Aero Medical Laboratory and the Personal Equipment Laboratory. This program studied the opening forces of silk and nylon parachutes at various altitudes. The opening forces in both 24 ft. and 28 ft. parachutes at various altitudes. The magnitude and duration of parachute opening forces at various altitudes and air speeds. The experiments were conducted at Muroc Army Air Field in the winter of 1944. The test data indicated that the accelerations varied from 8.5 G at 7000 feet to 33 G at 40,000 feet. The new 28 foot canopy made from nylon material produced the lowest accelerations at all altitudes (Mr. Lundquist, Prof. Ryan, Univ. of Minnesota, Dr. Baldes, Mayo Clinic, Major Hallenbeck, Lt. Penrod, Captain Maison, E. O. 695, 1944-1945)

Another experimental program was directed to the development of an automatic parachute opening device for long free fall bailouts. Through equipment tests the scientists measured the forces required for a man to manually open the standard backpack parachute and the standard chest pack parachute. They also studied and developed the first aneroid activated parachute opening device. They managed the contract with Friez Instrument Corp. which constructed these devices. They also made a series of dummy drops from altitudes as high as 15,000 feet to demonstrate that the device operated satisfactorily (Captain Maison, Lt. Martin E. O. 696-66A, October 25, 1944)

The Laboratory conducted an extensive testing program on aircrew clothing using the all weather room and the refrigerated low-pressure chamber. This work also included various combinations of temperature and wind movement. The thermal insulative value of the clothing was determined in terms of CLO units. (The CLO unit is the amount of clothing required to maintain comfort at 70 F with no wind) Concurrent with these equipment tests, the physiologic studies on the effects of climactic stresses, such as temperature, wind, humidity, and solar radiation, were

being conducted with human subjects. This work exposed the subjects to human tolerance limits for temperature and humidity (Mr. Hall, E. O. 696 1944)

The oxygen equipment program was totally involved in the engineering development of aircraft bottles, walk around bottles, bailout bottles, regulators and the associated hardware. They also conducted engineering modifications and handled the production engineering program. In 1944, the Laboratory started a program to develop a new liquid oxygen system to meet the demands of high speed long range jet flight.(Dr. Berner E. O. 660, 1944)

The medical logistics work in the Laboratory was devoted to development of facilities for the air transport of wounded, medical supplies, and medical equipment. The program covered research, development, testing, standardization and procurement. Litter supports and other small airborne medical equipment were developed. Two other items deserve special mention because of their widespread usefulness. The first was the aerosol bomb for dispersal of insecticides. Lt. William Sullivan in 1942, developed a portable bomb for dispersing a freon-pyrethrumsesame oil insecticide in aerosol form for the disinsectization of aircraft. The other item was the pneumatic balance resuscitator developed by Henry Burns in 1945. The resuscitator was developed for flying personnel who had succumbed to anoxia and frequently required artificial respiration.

The clinical aviation medicine program was devoted to the areas of ophthalmology and wound ballistics. In the ophthalmology area the studies were mainly directed along three lines of approach: studies of visibility and fields of vision from aircraft, design and development of goggles and flying sun glasses, and night vision studies (Captain Pinson, E. O. 690, 1941-1945)

In the area of wound ballistics there was little detailed information on the wounding effects of the standard ammunition in use during the war. Modern weapons, such as the machine gun, were often stated to have caused extensive damage to tissue. While undoubtedly true, these statements usually were unqualified and unsupported by specific data. For medical reasons, it was considered important to have detailed information whereby damage could be estimated. In the winter of 1944, experimental animals were used in these tests.

Colonel Randy Lovelace, Dr. Edward Baldes, and Lt. Verner Wulff traveled to England, Germany and Sweden in May and June 1945. Their purpose was to gather technical and scientific data on the development of the ejection seat. The results of this study were published in an AAF Memorandum Report TSEAL-3-696-74C in August 1945. The Laboratory, on the basis of this overseas study, initiated an ejection seat research program in July 1945. Under the direction of Major Harvey Savely, the program contracted for an ejection seat testing tower. This tower was 30 feet high and was adjustable up to 30 degrees aft of the vertical. There was an air brake to stop the seat near the top of the tower. It was constructed in three weeks by the Allis Chalmers Company under the direction of Dr. Baldes. The first AAF ejection seat used in these tests was a reproduction of the German ejection seat which had been brought back from Germany. The Frankford Arsenal provided a T-2 telescoping catapult that extended from 36 to 60 inches. Using a half charge of powder in the T-2 catapult, the first two human ejections were conducted on the 30 foot tower in November 1945. The seat accelerations were 11G and the subject accelerations were 20G on the hip, 15G on the head and 10G on the shoulder (Major Savely, E. O. 695, November 1945)

Two final projects worthy of note during the war were the preparation of the first service manuals concerned with high altitude health hazards, PHYSIOLOGY OF FLIGHT and YOUR BODY IN FLIGHT (1941) and the establishment of physiological training programs for aviators (1941).

AWARDS

1943	Lt Col. Lovelace	Distinguished Flying Cross

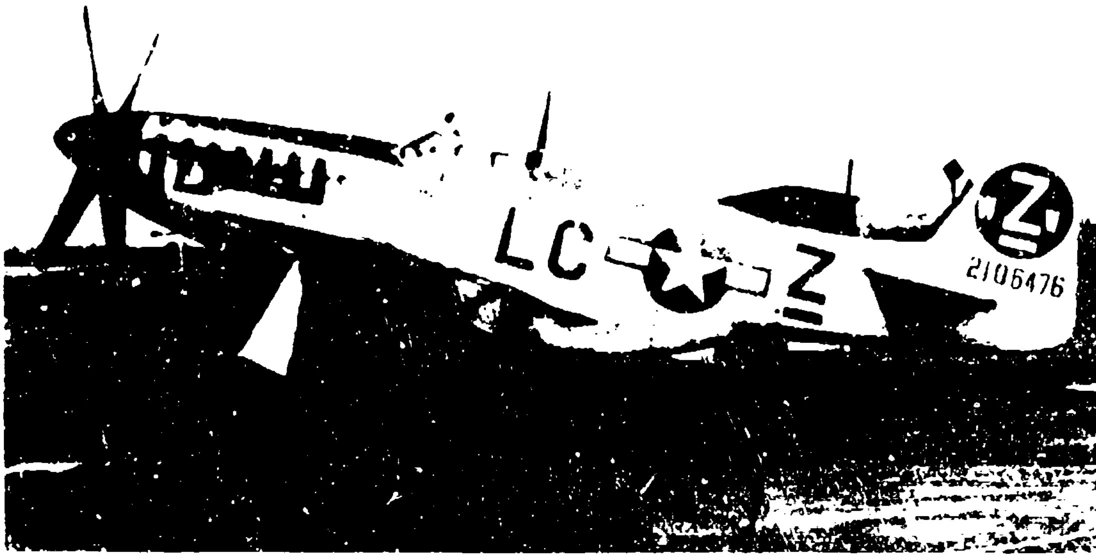


Fig II-1 P-51 aircraft. The performance in combat turns led to the development of the G-3 anti-G suit. This was the first type of operational aircraft to be equipped with the new anti-G suits. Aero Medical team leader in Europe, Lt. Martin

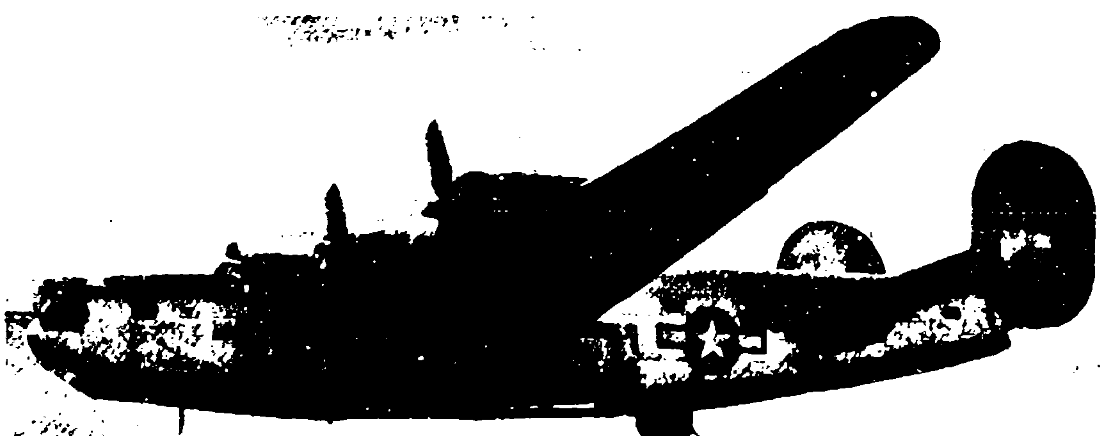


Fig II-2 B-24 aircraft. Required anthropometric sizing of the many gun turrets and internal crew equipment used by the services. Lt. Randall

Fig II-3 *B-17G aircraft. The extremely cold temperatures in the open rear gunners station prompted work with winter flying equipment and oxygen masks.*

Fig II-4 *B-29 aircraft. The sealed cabin required work on explosive decompression and pressure breathing equipment.*

Fig II-5 P-59 jet fighter. Its performance required significant advances in aero medical research, human engineering, high altitude physiology, ejection escape, clothing and oxygen equipment.

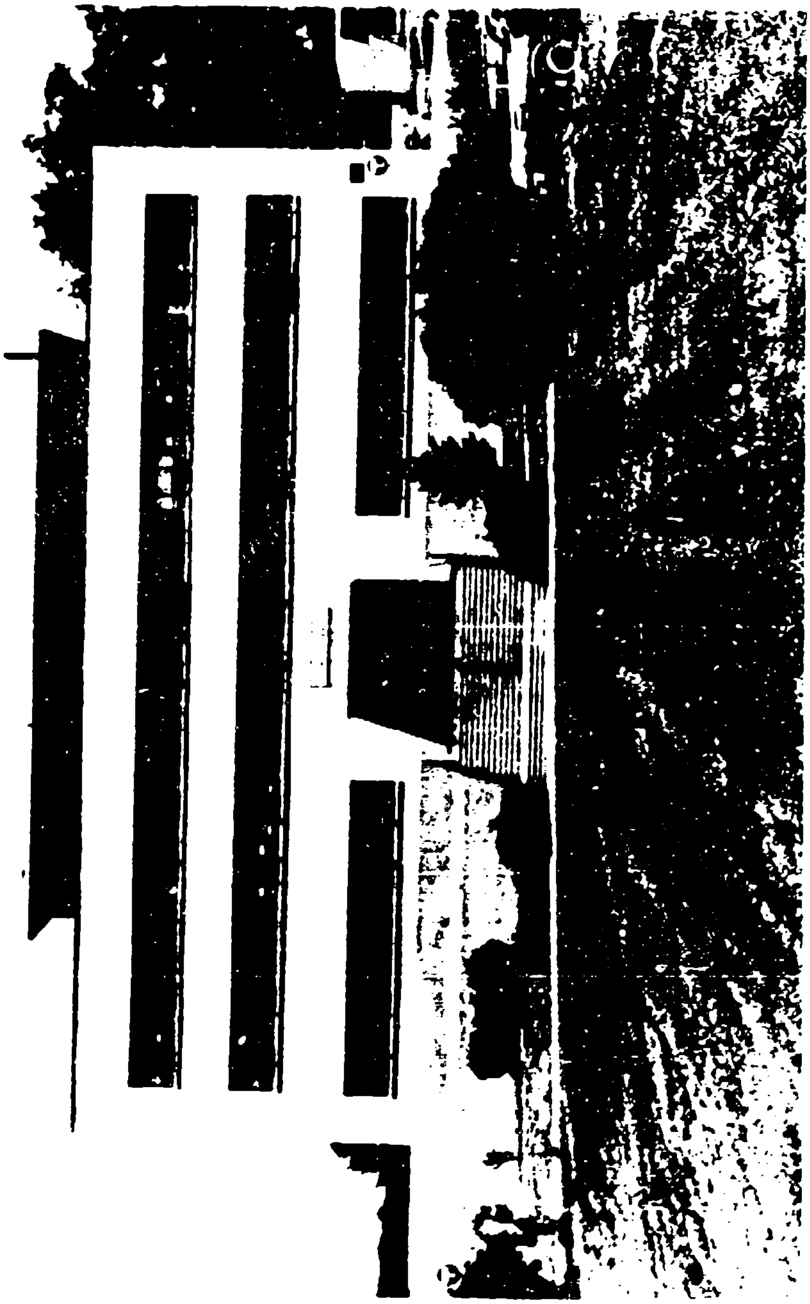


Fig II-6 The new Building 29 which was ready for occupancy on January 1, 1943.

Fig II-7 The new Aero Medical Laboratory complex, 1944.

Fig II-8 The second human centrifuge installed at Wright Field, Bldg. 55, May 1943. This machine was used in the development of the new anti-G suit.

Fig II-9 The Army Air Forces standardized G-3 anti-G suit, November 1944.

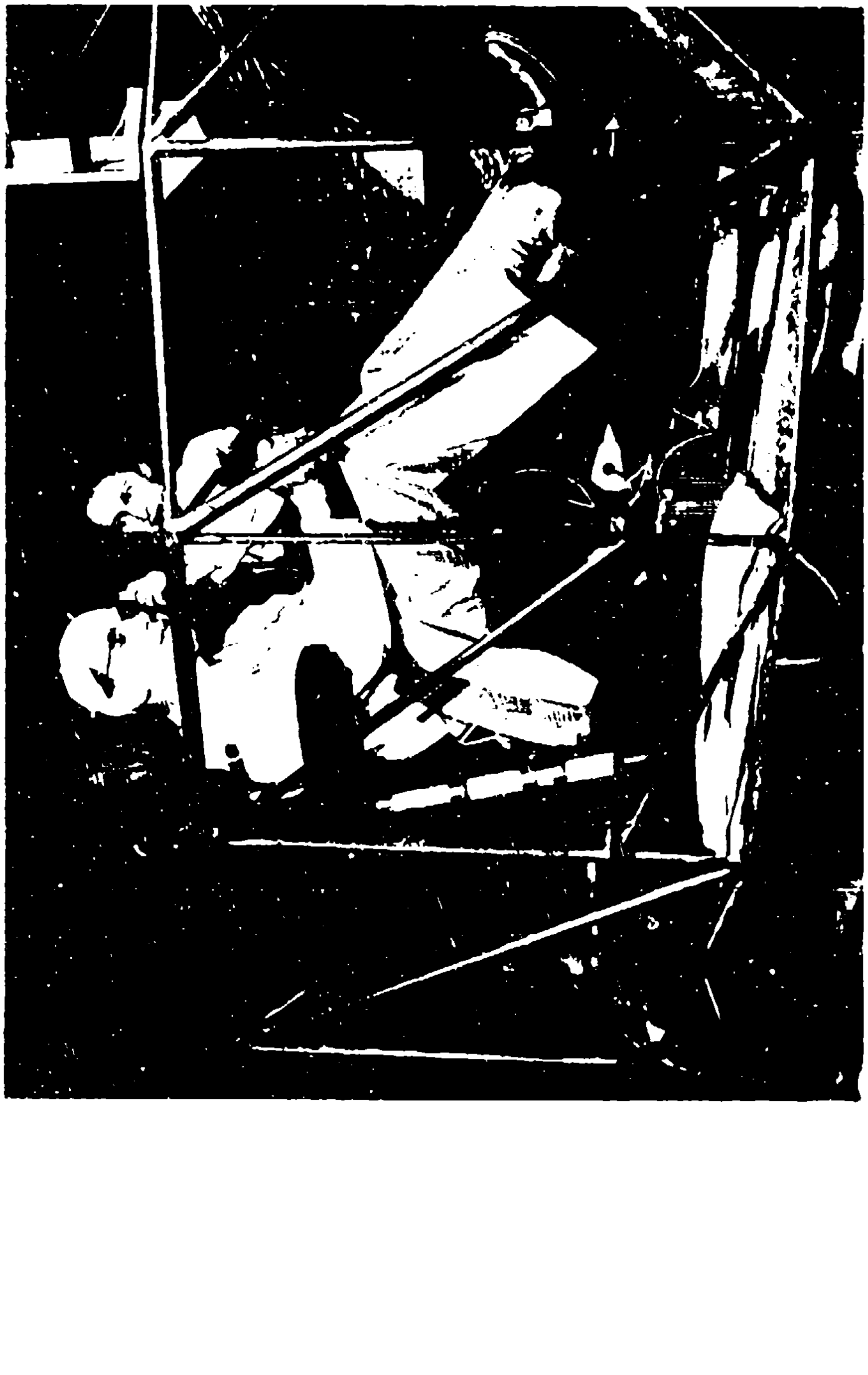


Fig II-10 Marjorie Martin attaching medical electrodes to a subject prior to an experiment on the centrifuge.

Fig II-11 Lt. Alexis Goster, at lift off from the ground in the first human pick-up. Wilmington Ohio, September 5, 1943.

Fig II-12 Lt. Alexis Coster, in trail at an altitude of twenty feet in the first human pick-up.

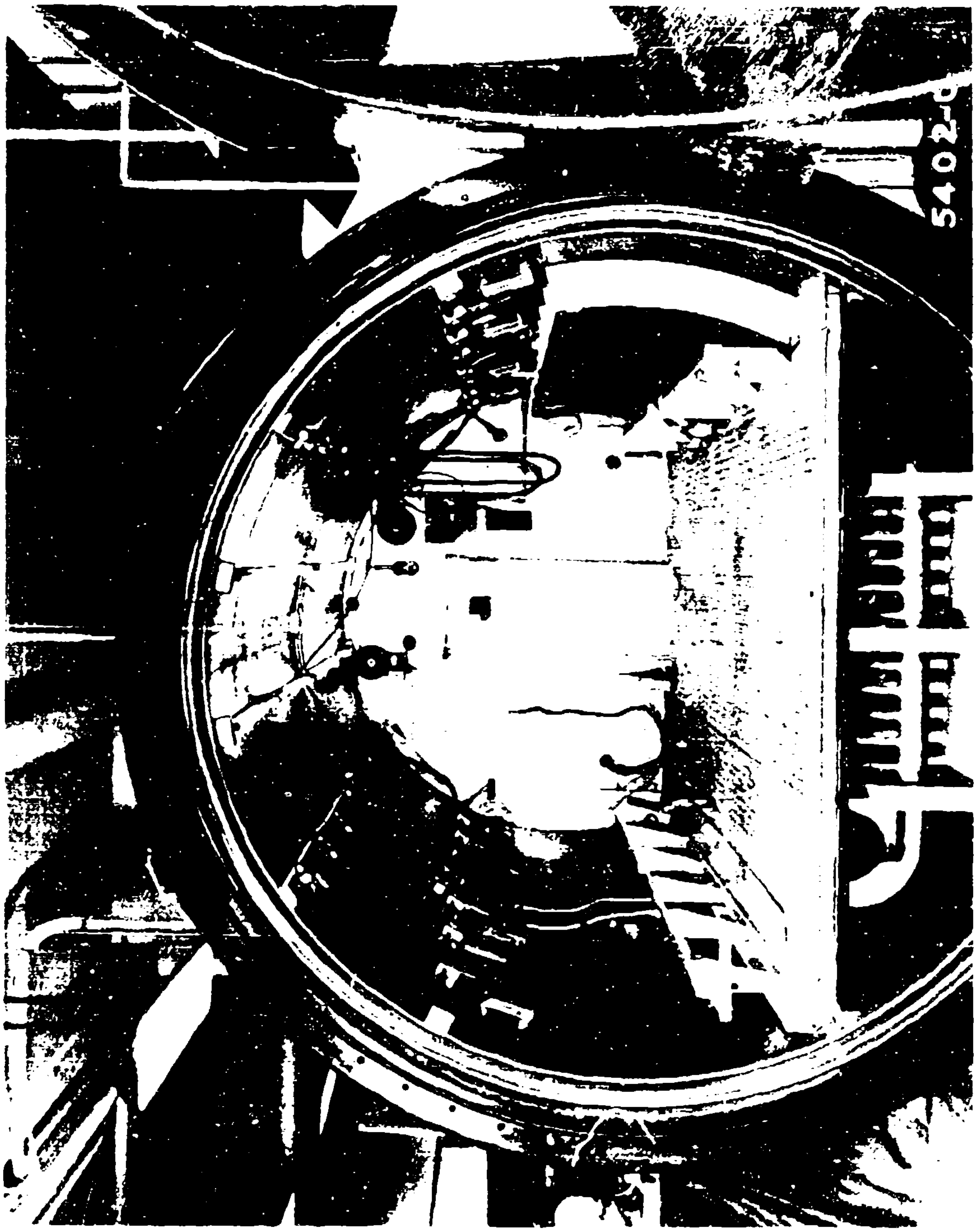


Fig II-13 Sixteen man altitude cold chamber located in the basement of Bldg. 29.

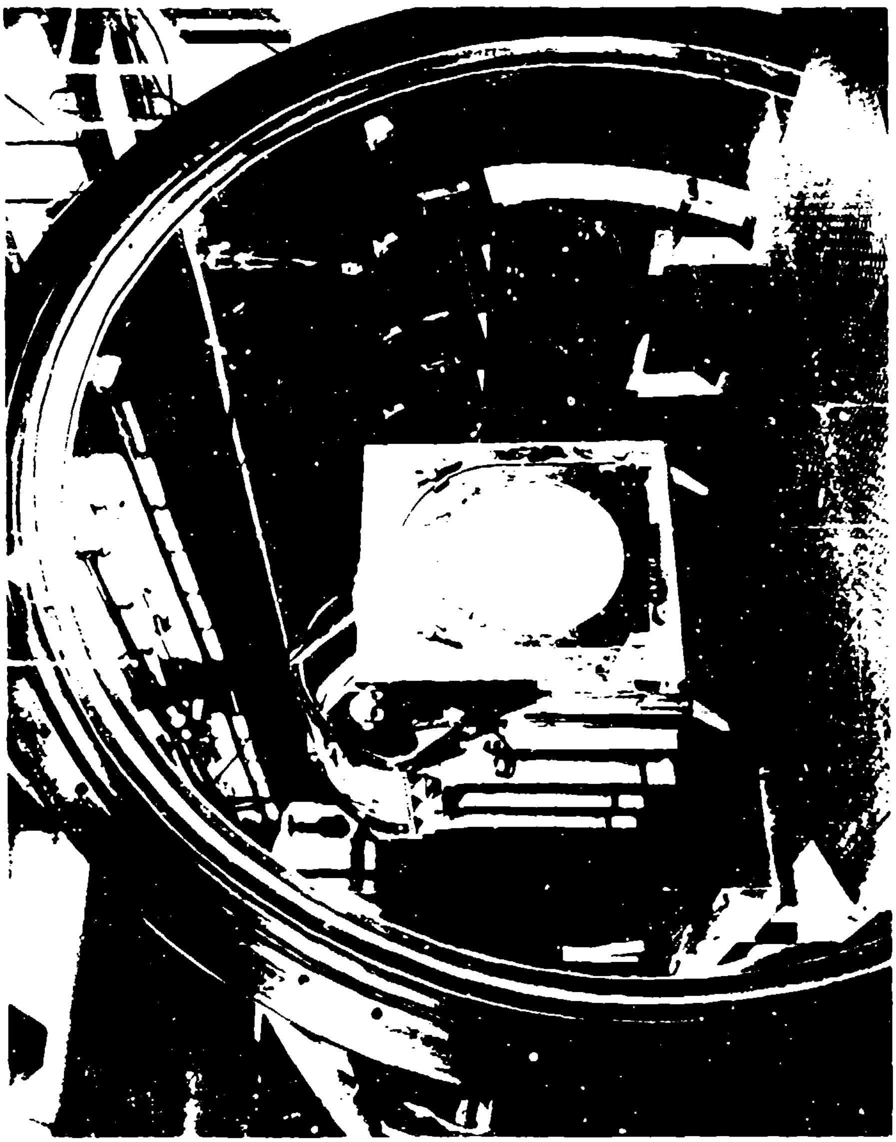


Fig II-14 *Explosive decompression cockpit in the altitude chamber. This test set up developed the initial AAF decompression standard for fighter aircraft Major Sweeney, May 1943.*

Fig. II-15   Twenty man altitude chamber located in the basement of Bldg. 29

Fig. II-16   Sgt. [illegible] at the controls of the twenty man altitude chamber [illegible] basement [illegible]

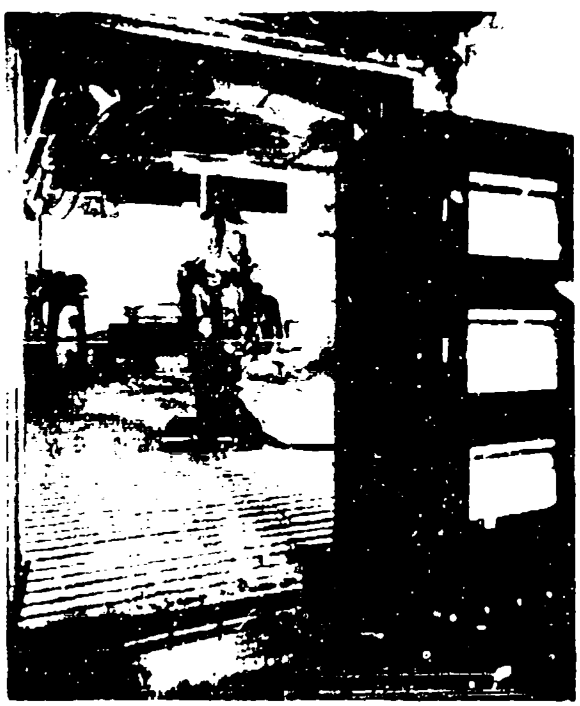


Fig. II-18. High-altitude [illegible] parachute program. Lt. Martin [illegible] [illegible] 1943

Fig II-19 High altitude flight equipment used in B-17, B-24, B-29. This personal equipment was tested in the Laboratory facilities, Captain Taylor.

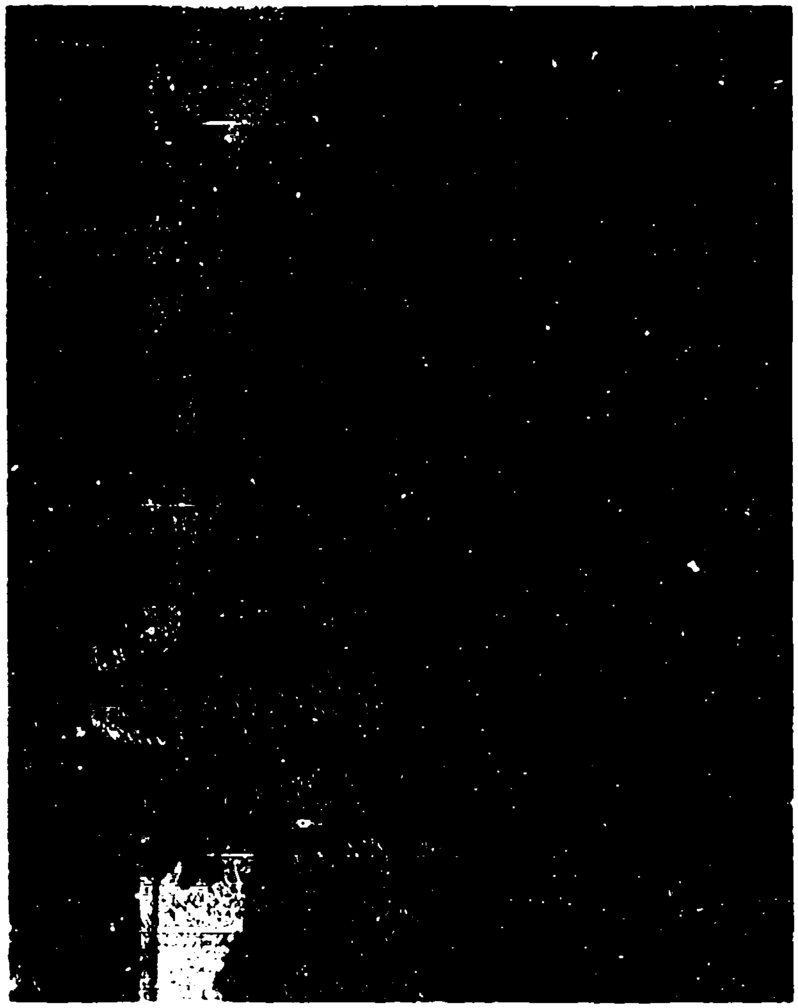


Fig II-20 Four man quonset type pnuematic shelter.

Fig II-21 Modified German ejection seat brought back from Europe and used for the first American human tests on the 30 foot ejection tower, 1945

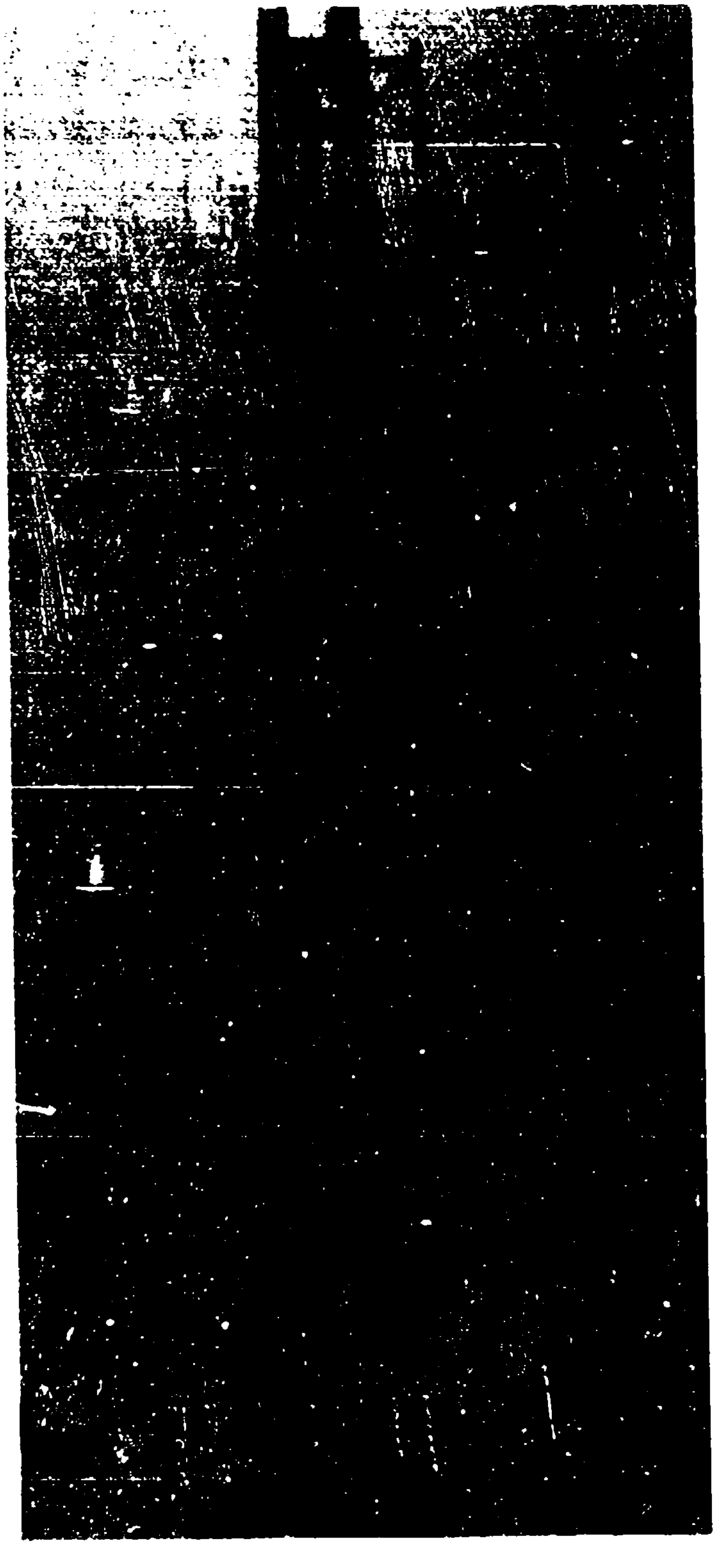
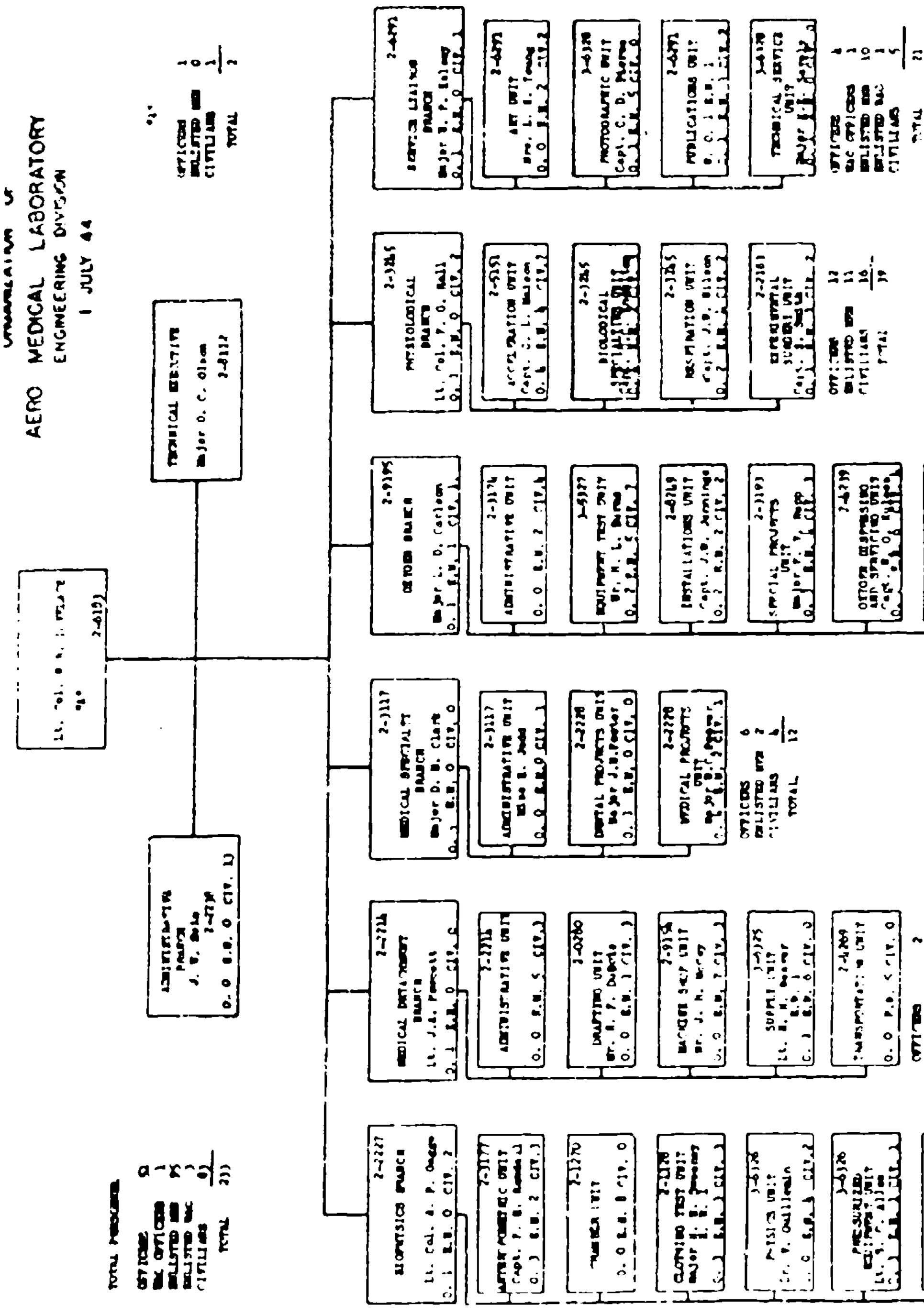


Fig II-22 The thirty foot ejection tower. The first ejection test facility in the AAF, 1945.



[illegible] Laboratory organization on July 1, 1944.

5th Row
Lt. Sassenberg, Unknown, Unknown, Lt. Bachrach, Lt. Stacey, Lt. Musgrove, Lt. Wulf, Lt. Bowman.

4th Row
Lt. Benton, Unknown, Lt. Bartlett, Lt Damon, Lt. Rousch, Lt. Chapanis, Unknown, Unknown, Unknown, Lt. Martin.

3rd Row
Unknown, Capt. Taylor, Capt. Randall, Unknown, Capt. Wilson, Capt. Mauske, Capt. Knowlton, Unknown, Unknown, Unknown.

2nd Row
Lt/Col. Rupp, Lt/Col. Fitts, Capt. Grether, Capt. D'Angelo, Capt. Swann, Capt. Allen, Unknown, Unknown, Capt. Romeko, Unknown, Capt. Hickam, Unknown.

1st Row
Major Sweeney, Major Savely, Major Pinson, Major Carlson, Lt/Col. Berger, Lt/Col. Hall, Col. Loveluce, Lt/Col. Gagge, Major Lightner, Major Kelsey, Unknown, Unknown.

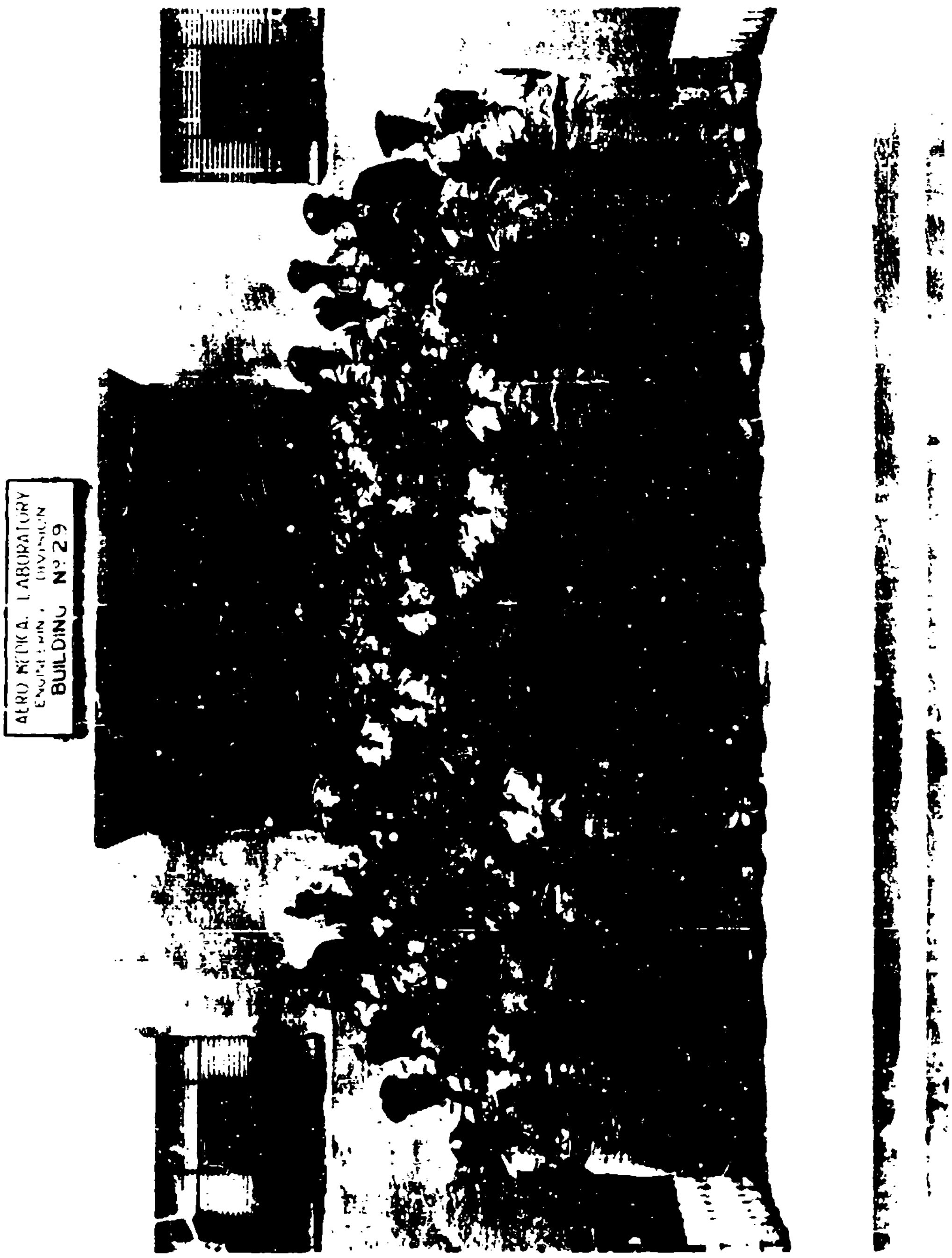


Fig 11-24 Officers assigned to the Laboratory in 1945

CHAPTER THREE

JET FLIGHT RESEARCH 1946-1958

ORGANIZATION AND COMMAND

Colonel Edward J. Kendricks was assigned as Chief, Aero Medical Laboratory in May 1946.

A special group of German scientists and their associated technical support personnel were assigned under "Project Paper Clip," to the Aero Medical Laboratory in May 1947. They had been involved in related aero medical research during the war. Primarily from the Helmholtz Institute in Bavaria, they were Dr. Hans Mauch, Dr. Henschke, Dr. Ernst Franke, Dr. Otto Gauer, Dr. Henning Von Gierke, Dr. Hans Oestreicher, Mr. Henry Seeler, Dr. Hans Amtmann, Mr. Frank, Dr. Ernsthausen, Mr. Fritz Klemm, Mr. Willie Buehning, Mr. Franz Rinecker, Mr. Paul Hermann, Mr. Wolf Von Wittern, and Mr. Erich Gienapp.

An Aero Medical remote location facility was established at Muroc Army Air Field, California in 1946. Lt/Col. Mike Sweeney sent Captain John Paul Stapp to the 2000 foot track to build a rocket sled and conduct human and animal experiments in abrupt acceleration.

The Personal Equipment Laboratory transferred responsibility for research and development on all clothing to the Aero Medical Laboratory on April 12, 1947. Mr. Don Huxley was appointed Chief, Clothing Branch. Other members of the Clothing Branch were Mr. Abe Plotkin, Mr. Bill Walker, Mr. Lennie Moore, Mr. Roy Harlan, and Mrs. June Murphy. The Clothing Branch occupied two offices on the first floor of Bldg. 29.

United States Air Force was activated on September 18, 1947.

Construction of Bldg. 33 was completed in the fall of 1947. The human centrifuge in Bldg. 55 was disassembled in summer 1948. Clothing Branch moved into the refurbished building in October 1948. The Clothing Branch was the center of all new developments in uniform clothing, flight clothing and personal protective clothing in the Air Force.

The Aero Medical Field Laboratory was established at Holloman Air Force Base, New Mexico, in 1949. It provided technical assistance for the Aerobee rocket flights using animals. Several years later it became the primary facility for abrupt acceleration sled tests, under the supervision of Lt/Col. John Paul Stapp.

Col. Kendricks was transferred from the Laboratory in June 1949. Lt/Col. Adolph P.Gagge (MSC) served as Acting Chief of the Laboratory from June 1949 until December 1949. Colonel Walter A. Carlson was assigned as Chief, Aero Medical Laboratory in December 1949.

Dr. Paul Fitts, founder of the Psychology Branch in the Army Air Forces, departed the Laboratory in 1949. Dr. Walter Grether was assigned as Chief.

Air Research and Development Command (ARDC) was established on April 2, 1951.

The Aero Medical Laboratory was transferred from the Directorate of Research and Development, Air Materiel Command, to Wright Air Development Center, ARDC, in accordance with ARDC G.O. No. 10, June 7, 1951.

Colonel Walter A. Carlson was transferred and Colonel Robert H. Blount was assigned as Chief, Aero Medical Laboratory, in June 1951. Colonel Jack Bollerud was assigned as Chief of the Laboratory, in January 1955. Dr. Harvey Savely departed the Laboratory for the Office of Scientific Research, in 1956. Wright Air Development Center (WADC) combined all the Laboratories into the single Directorate of Laboratories in July 1957. Colonel Bollerud was transferred in April 1958. Colonel John P. Stapp was assigned as Chief, Aero Medical Laboratory.

N A C A was reorganized into the new N A S A to conduct the civilian space program in July 1958.

In the spring of 1958, the Aero Medical Laboratory was reorganized into a three Division management structure with Captain Edward DeWilton (USN) Chief, Bio-Medical Sciences Division, Mr. Wayne McCandless, Chief, Engineering Division, and Lt/Col. Howard Parris, Chief, Behavioral Sciences Division.

The greatest increment in growth of the Behavioral Sciences Division occurred in 1958 when the Air Force Personnel and Training Research Center, with headquarters in San Antonio, Texas, was abolished. The Behavioral Sciences Division was given added responsibilities in the areas of operator and maintenance training and qualitative personnel requirements information (QPRI).

As a consequence of this increased responsibility, the Behavioral Sciences Division established a new Branch, Training Psychology, headed by Dr. Gordon Eckstrand.

U. S. AIR FORCE AIRCRAFT

F-80, F-84, F86, F89, F-94, F-100, F-101, F-102, F-104, F-105, F-106, B-29, B-36, B-45, B-47, B-50, B-52, B-57, B-58, B-66, C-119, C-123, C-124, XC-130, C-131, C-135, T-28, T-29, T-33, B-34, X-1, X-2, X-15, XB-46, XB-51, XB-60(NPA)

CHALLENGING AEROMEDICAL PROBLEMS

- Organize and create the first human engineering research program in the Army Air Force
- Establish the human tolerance limits and protective equipment requirements for ejection escape system in the Air Force
- Develop the first operational pressure suits in the Air Force
- Organize and establish the human tolerance limits and standards for bioacoustics environments in the Air Force
- Initiate the first noise survey and land use program in the Air Force
- Establish the first physiological and psychological requirements for low earth orbit space flight
- Develop an operational liquid oxygen system for high altitude jet flight
- Develop uniform, flight clothing, and protective clothing for the new jet aircraft era

PIONEERING ACHIEVEMENTS

- First demonstration of the S-1 partial pressure suit in an altitude chamber (Dr. Henry, E. O. 696, 1946)
- First flight tests of the five liter liquid oxygen converter (Dr. Berner, E. O. 660, 1946)
- Design of Air Forces standard B-2 Navigational Plotter (Dr. Christensen, E. O. 684, 1946)
- First shape coding of aircraft cockpit controls for improved human performance (Dr. Jenkins, E. O. 694, 1946)
- First studies of instrument reading performance under acceleration on the centrifuge (Dr. Warrick, Dr. Lund, E. O. 694, 1946)

- Participate in the first live in-flight ejection seat test in the Army Air Force with subject Sgt. Larry Lambert in a P-61 aircraft at Patterson Field. velocity 228 KTS. altitude 7800 feet (Major Sweeney. E. O. 695. August 17, 1946)
- High altitude sky brightness measurements for vision problems when using the CRT in the navigator-bombardier crew station (Dr. Christensen, E. O. 694, 1946)
- Research on Navigators' performance during Arctic high- altitude flights (Dr. Christensen, E. O. 694, 1947)
- Research on flight instrument design and legibility (Dr. Grether, E. O. 694, 1947)
- First human tolerance studies in linear deceleration using a rocket sled on a 2000 foot track at Muroc Army Air Field, California (Captain Stapp, E. O. 695, 1947)
- Establishment of human tolerance for upward ejection seat accelerations (Dr. Ames, Dr. Savely, E. O. 695, 1947)
- Studies of human performance in the direction of movement of controls (Dr. Warrick, Dr. Grether, E. O. 694, 1947)
- Development of pointer alignment principle for rapid check reading of cockpit instruments in an emergency situation (Dr. Warrick, Dr. Grether, E. O. 694, 1948)
- Study of pilot eye movements in flight to establish instrument reading pattern (Dr. Fitts, Major Cole, E. O. 694, 1948)
- First research program which led to the development of P-1 helmet (Mr. Moore, E. O. 666, August 20, 1948)
- Research on the physiological effects of intense sound (Dr. Parrack, E. O. 695, 1948)
- Research program to establish the mechanical impedance of the body. (Dr. Franke, Dr. von Gierke, E. O. 695, 1948)
- First downward ejection test tower for human testing (Dr. Savely, E. O. 695, 1948)
- Establishment of human tolerance to downward seat ejections (Dr. Shaw, E. O. 695, 1948)
- First anthropological research on the prone pilot position (Mr. Hertzberg, E. O. 695, 1948)
- First animal experiments using V-2 rocket at White Sands, N.M. (Dr. Henry, E. O. 695, June 18,1948)
- Research on the effects of control lag on human performance (Dr. Warrick, E. O. 694, 1949)
- Publication of the first Blue Book on UFO phenomenon (Dr. Fitts, E. O. 694, 1949)
- Air Force high speed human ejection, Capt. Vincent Mazza, P-61 aircraft, 555 MPH at 9000 feet at Patterson Field (Mr. Santi, Captain Mazza, Mr Carroll, 1949)
- Research on the effects of training transfer as related to the design of training equipment (Dr. Eckstrand, E O 694, 1949)
- Second series of animal experiments using V-2 rocket at White Sands N.M. (Dr. Henry, E. O. 695, 1949)
- First human test of the downward ejection seat in a B-47 aircraft (Lt/Col. Henderson, E. O. 695, 1949)
- First human engineering applications group initiates a system study of the Air Weather Service (Dr. Danielson, Mr. King, E. O. 694. 1949)
- Major anthropometric survey of Air Force flying personnel (Mr. Hertzberg, Lt. Daniels, E. O. 695, 1950)
- First animal cosmic ray balloon flights to 97,000 feet (Major Simons, E. O 695, 1950)
- Incorporation of body size criteria into Air Force manuals (Lt. Daniels, RDO 695, 1951)
- First Aerobee high rocket flights using monkeys and mice (Dr. Henry, RDO 695, April 18, 1951 and September 20, 1951)
- Human engineering research on low color temperature white lighting (Dr. Grether, RDO 694, 1952)

- First operational partial pressure suit S-1. Based on the work of Dr. Jim Henry (Captain Vail, RDO 696, 1952)
- First human tests to 12 G in the prone and supine body position (Lt. Dempsey, Capt. Ballinger, RDO 695, 1952)
- Aerobee rocket flights with animals, two monkeys and two mice, altitude 38 miles (Dr. Henry, RDO 695, May 22, 1952)
- High-altitude downward ejection tests from a B-47 aircraft (Mr. Hecht, Mr. Beaupre, Captain Sperry, RDO 695, 1953)
- First human tolerance studies on high altitude free fall spinning, using a laboratory spin table (Captain Edelberg, RDO 695, 1953)
- Standardization of the T-1 partial pressure suit developed by Dr.Henry (Captain Vail, RDO 696, 1953)
- First high altitude human spin tests during a parachute free fall (Lt. Neilsen, 7222, 1954)
- First tiltable ejection seat to relieve aircrew fatigue during long-range flight (Mr. Dempsey, 7222, 1954)
- Handbook on the visual presentation of information (Mr. Baker, Dr. Grether, 7184, 1954)
- First human engineering research on air traffic control (Dr. Queal, 7184, 1954)
- Development of the first successful ventilation garment for body cooling when wearing a full pressure suit or other protective garments (Dr. Mauch, 7164, 1954)
- World record sled test at Holloman AFB using a human subject, 632 MPH (Lt/Col. Stapp, 7222, 1954)
- First research program to conduct aircraft noise field surveys (Dr. Parrack, 7231, 1955)
- Research program on human performance in long range flight (Dr Chiles, 7184, 1955)
- First omnienvironmental protective suit development program (Mr. Martin, 6373, 1955)
- Formulation of the Human Engineering Applications program (Mr. Ring, 7184, 1956)
- First standard height-weight sizing system for all personal protective equipment, except the oxygen mask and helmet (Mr. Emanuel, 7222, 1956)
- World record ascent in an altitude chamber with a human subject, 198,700 feet (Major Beck, 7164, 1956)
- First Biological Data Handbook series (Dr. Heim, 1956)
- Criteria for short time exposure to high intensity jet aircraft noise (Captain Eldred, Major Gannon, Dr.von Gierke 7231, 1956)
- Influence of training on the design of aircraft control coding (Dr. Eckstrand, Dr. Morgan, 7184, 1956)
- Three dimensional sizing system for Air Force clothing (Mr. Alexander, 7222, 1957)
- Joint AMRL/FAA determination of mass, centers of mass, and moment of inertia of the major segments of the body (Mr. Clauser, 7184, 1957)
- First full pressure suit (X-15) (Capt. Vail, 7164, 1957)
- First basic procedures established for land use with respect to airplane noise (Lt/Col. Guild, Mr. Cole, Dr. von Gierke 7231, 1957)
- First USAF MAN IN SPACE program (AMRL Staff, 1957)
- First research program on the biophysics of concussion (Dr. Hollister, 7222, 1957)
- A new technique for establishing human body contour by means of sterephotogrammetry was successfully developed. (Mr. Hertzberg, 7222, 1957)
- Publication of MIL-H-25946, Human Factors for Manned Aircraft Weapon Systems (Mr. Griffin, Mr. Ring, 7184, 1957)
- Publication of MIL-H-26207, Human Factors Data for Missile Weapon Systems (Lt. Kibler, Mr. Bates, Mr. Greek, 7184, 1957)

- First successful test of hand-held propulsion gun for use in zero gravity (Mr. Hertzberg, 7222, 1958)
- First airborne weightlessness training program, C-131 (Captain Simons, Major Brown, 7184, 1958)
- First aircrew habitability studies of nuclear powered aircraft (Mr. Dempsey, 7222, 1958)
- First human tests to 16 G in the supine body position (Captain Clarke, 7222, 1958)
- Study of vibration and noise environments of missiles and spacecraft (Dr. Von Gierke, 7231, 1958)

PROJECT NUMBERS	TITLES
660	Oxygen Equipment
666	Air Crew Clothing
670	Survival Equipment
689	Anti-G equipment
690	Eye Protection Equipment
691	Feeding Equipment
694	Psychology Research
695	Acceleration Research
696	Physiology Research
698	Medical Equipment
1710	Training
6301	Radiation Protection
6302	Toxicology
6311	Clothing
6373	Life Support Equipment
7164	Physiology
7184	Human Engineering
7222	Biophysics
7231	Bioacoustics

FACILITIES

Construction	Bldg 33	(1947)
Rehabilitation	Bldg 55	(1948)
Construction	Bldg 248	(1954)
Construction	Bldg 824	(1955)
Construction	Bldg 441	(1957)

Downward Ejection Tower	Bldg 23
Vertical Accelerator	Bldg 23
Altitude chamber	Bldg 29
All weather room	Bldg 29
Thermal chamber facility	Bldg 29
Copper manikin	Bldg 29
Vision test facility	Bldg 29
Library	Bldg 29
Link trainer facility	Bldg 29
Animal surgical room	Bldg 33
Spin table	Bldg 33
Third Human Centrifuge	Bldg 33
Bioelectronics laboratory	Bldg 33
Acoustical chambers	Bldg 33
Instrumentation Laboratory	Bldg 33
Clothing fabrication facility	Bldg 55

100 foot vertical ejection tower	Bldg 65
Training simulator facilities	Bldg 190
Visual simulation and analog computer	Bldg 190
Instrumentation laboratory	Bldg 190
Laboratory auditorium	Bldg 196
Sculptor shop	Bldg 196
Visual performance simulator	Bldg 196
Anthropology strength laboratory	Bldg 196
Altitude chamber	Bldg 197
Remote manipulator	Bldg 197
Frictionless air bearing platform	Bldg 197
Machine shop, wood shop and supply	Bldg 198
Biochemical laboratories	Bldg 248
Nutrition Laboratory	Bldg 248
Altitude chamber	Bldg 248
Acoustics Chamber	Bldg 441
Electronics laboratory	Bldg 441
Speech recognition laboratory	Bldg 441
Survival equipment test facility	Bldg 824
Oxygen equipment test facility	Bldg 824

Laboratory Flight Test Aircraft

C-45	Psychology Branch
C-47	Psychology Branch
C-131	Psychology Branch
B-17	Biophysics Branch/Engineering & Development Branch
F-82	Biophysics Branch
F-80	Biophysics Branch (Prone Pilot)

THE LABORATORY PROGRAMS

OVERVIEW

The new era of Jet Flight required fundamental aeromedical medical research on the significantly increased flight velocities, the high acceleration forces, the extremely short event times for human response, and the very high altitude flight profiles. Military aviation had suddenly moved from propellers to jets, and was rapidly approaching the first attempt at human flight in near earth orbit.

The first organized research in engineering psychology began in this Laboratory in 1945. The experiences of the war had more than demonstrated a fundamental need for human engineering research in the design of aircraft equipment, training procedures, and aircrew combat training in emergency situations. The Army Air Force was fortunate that the great leaders in such research were brought to the Laboratory through the foresight of Colonel Lovelace.

Lt Col. Paul Fitts and Major Walter Grether were given full responsibility for planning and organizing the new research program. Their technical program plan organized the work into four areas: research activities, coordination of university research, consultation with scientists and engineers from other Wright Field laboratories and liaison with outside agencies. These four areas were then integrated into two research activities. The first was to conduct research on the past problems and apply the data to correct current needs, and to prevent intermediate term future problems. The second was to initiate an advanced research program which dealt with the new requirements of jet aircraft and to have technical data available for their preliminary

design. This comprehensive activity stretched the limits of the available human engineering manpower, approximately 25 people.

That new human engineering program started exactly ten years after the approval of the Physiological Research Laboratory. Fitts and Grether in aviation human engineering research (1946) were comparable to Armstrong and Heim in aviation physiology research (1936).

The Aero Medical Laboratory was now totally engaged in the professional areas of human engineering, biophysics, physiology, engineering, clothing, medical specialities, and aviation equipment development. The Laboratory work in those fields covered: basic and applied research, new engineering developments and the standardization of new equipment items. The research, development, and standardization of end item specifications and drawings represented approximately one-half of the Laboratory output. The remainder of the Laboratory work was directed toward supplying information for the Handbook of Instruction for Aircraft Designers, and for technical reports used by other military organizations and aviation contractors.

SELECTED PROGRAMS

A significant percentage of aircraft accidents resulted from confusion of the pilot in reading instruments, selection and location of controls, etc. Part of this confusion was a result of the variation in cockpit arrangement from one aircraft to another. The Labortory participated in a coordinated USAF program to standardize cockpit arrangement, as well as codify controls through uniform and distinctive knob design. An example of the results of this work, the Office of Technical Inspection and Flight Safety informed this Laboratory that elimination of the confusion between the landing gear and wing flap controls had virtually eliminated the accidental raising of the landing gear while the aircraft was on the ground (Dr. Jenkins, E. O. 694, 1946)

The design of jet aircraft demanded more compact and lighter oxygen equipment. An engineering program was initiated to produce a satisfactory system for storing liquid oxygen on the aircraft and converting it into aviator's breathing oxygen in gaseous form as required. The high density of the liquid as compared to gas resulted in a saving in space of approximately 30 to 1. Since the oxygen could be kept in a liquid state by insulation from the surrounding atmosphere, heavy steel containers were not required, as is the case with storing compressed gas. These efforts resulted in the standardization of the 5 liter, Type A-3 Liquid Oxygen Converter. The LOX system was first installed in the F-84 aircraft (Dr. Berner, E. O. 660, 1946)

The advent of jet aircraft with extremely loud noise generators posed the problem of protecting flying and maintenance personnel from noise intensities never encountered before and poorly understood at that time. In a series of reports and publications the Laboratory provided a comprehensive, quantitative study of the hazards of high intensity noise and ways to protect Air Force personnel (Dr. Parrack, Dr. von Gierke, Mr. Cole, E. O. 695, 1947)

The Clothing Branch was responsible for the design and development of specialized ground crew protective clothing, as well as uniform and functional clothing. The fire entry suit and fire fighter's suit were two examples of the specialized protective garments. Personnel engaged in combating fires of high temperature, such as gasoline or fuel oil fires, needed a high degree of protection against radiant heat. A suit assembly, designed to be worn over the standard fireman's coat and trousers, was developed. The assembly consisted of an outer shell made of aluminized asbestos-fiberglas material and a lining of viscous rayon (Mr. Huxley, E. O. 666, 1948)

A new regulator (D-2) was developed for dispensing breathing oxygen to aircrew at altitudes up to 50,000 feet at the required pressure and concentration. It was completely automatic and did not require any adjustments from the aircrew. This regulator corrected latent faults uncovered in the old regulator (Mr. Good, E. O. 660, 1948)

Six German V-2 rockets had been sent to this country after the war. They were used for high altitude physics research by the Cambridge Research Center. The third V-2 rocket experiment was scheduled for flight dynamic studies of the X-2 escape capsule. Dr. Henry was asked to provide a "simulated pilot" to ride in a small capsule inside the nose cone, which was externally shaped like the nose of the X-2 aircraft. The monkey and the nose cone were instrumented to obtain information on the flight forces. The parachute failed to deploy and the monkey was lost. There were two additional flights with monkeys. The last flight carried a mouse. The four

experiments gathered valuable instumentation data during flight but all the parachutes failed and the animals were lost. Dr. Henry then obtained three Aerobee rockets to continue the research program. The first Aerobee carried a single mouse, an instrumentation package, and an onboard camera. The miniaturized camera and instrument package had been built by Mr. Eric Gienapp in his machine shop in Bldg. 33. The recovery parachute failed and the animal was killed. The second Aerobee carried two mice, one monkey, and the Gienapp instrumentation package. The flight was a success with full recovery of the nose cone. The three animals died after landing because of excessive heat stress inside the nose cone before they could be removed. The third Aerobee flight was completely successful. It carried two monkeys and two white mice. The Gienapp instrument package and camera provide excellent scientific data. These animals became the first living creatures to survive the test program. They flew to an altitude of 211,200 feet, a speed of 2000 MPH, and had been in a zero g environment for two minutes. (Dr. Henry, Dr. Gauer, Major Simons, Major Maher, Captain Ballinger, Mr. McLennan, Mr. Correll, Mr. Gienapp, Mr. Childers, Mrs. Petitt, E. O. 695, 1948-1952)

A new anthropometric survey was conducted on Air Force flying personnel and 132 measurements were made on over 4000 men. One of the first applications of this work was the establishment of a complete sizing schedule for the T-1 altitude suit and the new AF/Navy anti-G suits. A fit test of the latter garment resulted in better than 99.5% successful fittings of twelve sample sizes on a group of over 200 Navy personnel. Previous sizing schedules for that garment had usually produced only 80 to 90% successful fittings (Mr. Hertzberg, Lt. Daniels, E. O. 695, 1950)

Mr. Henry Seeler developed a resuscitator capable of operating at varying altitudes for use in combat or aeromedical evacuation type aircraft. A prototype resuscitator was produced. It was a versatile instrument that could be used in either aircraft or any place a low power electrical source was available. It produced negative and positive pressures, thereby blowing air or oxygen into the lungs and then sucking out the air to be exhaled. The advantages of this device could not be over emphasized. It would serve the Air Force in aeromedical evacuation, the ground forces in ambulance installations, and all branches of Service in various types of hospitals. The Army Chemical Center had also become interested in its use in the treatment of large numbers of patients suffering from chemical weapons effects. The resuscitator was particularly suited for treatment of those people that might suffer from "nerve gas" (Mr. Seeler, RDO 698, 1952)

Downward ejection gave the aircraft designer an alternate method for escape from aircraft. Factors that precluded the possibility of upward ejection were radar or instrument location, location of air scoops or the rudder to a given crew position and crew station on the lower deck of multiplace aircraft. Downward ejection required a modified harness to insure that the force of ejection was distributed to the body in a manner that would prevent injury. The seat also incorporated restraint devices to insure that the arms and legs were properly positioned during ejection. These features were tested by human subjects on the downward ejection test tower and were found to be adequate within the limits of human tolerance. A windblast testing program was conducted, using helmets, visors, and masks to determine their retention capabilities during high speed escape. The windblasts ranged from approximately 336 to 788 MPH. Standard P-3 helmets and visors proved to be sufficiently strong to withstand the most severe windblast (Captain Sperry, Lt. Neilsen, RDO 695, 1953)

Ejection from high speed aircraft introduced a complex problem: the effects of multidirectional acceleration forces on the human body coupled with a rapid tumbling rate. The tumbling which occurs immediately after clearing aircraft structure produces rotation about a center within the body. Laboratory studies on the physiological and pathological effects of rapid tumbling on animals and humans were conducted with a spin table. Critical values of rotational speed about an axis through the abdomen and the heart in humans were determined. These studies furnished information to designers about the degree of stability required in ejection seats. Concomitant with the tumbling problem, new restraints and harnesses were developed to maintain man in the ejection seat (Captain Edelberg, Captain Weiss, RDO 695, 1953)

Atomic weapons created the need for nonmedical personnel to rapidly apply a sterile dressing for mass therapy of burns. Aeroplast was a sprayable film-forming transparent plastic dispensed from aerosol containers. The most important advantages of that form of local burn therapy was time saving, feasibility of its use by relatively untrained personnel, applicability to parts of the body poorly adapted to pressure dressings, transparency, flexibility, minimal storage problem,

absence of tourniquet effects, and possibility of use under field conditions. Wounds dressed with Aeroplast healed at an identical rate to those dressed with petrolatum gauze. The results of two months of clinical trials showed that Aeroplast also seemed to hold promise as a general surgical dressing (Lt. Choy (MC), RDO 696, 1953)

The Air Force T-1 partial pressure suit assembly was developed to meet high altitude emergency requirements. Its development was the result of Dr. Jim Henry's seven years of intensive team research. Dr. Henry served as subject in tests up to 106,000 feet in the altitude chamber. In addition to fulfilling the altitude requirement, the T-1 assembly provided anti-g suit protection, and contained communication equipment, oxygen valves, regulators, protective helmet, protective visor, and oxygen bailout cylinder. The helmet was windblast tested to a velocity of 725 MPH. The T-1 suit was standardized by The Air Force in May 1953 (Dr. Henry, RDO 696, 1953)

The Army Air Force provided canned survival rations and poorly stored table food to aircrews during the war. The extended range flight of new jet aircraft created a fundamental need for in-flight feeding equipment and the development of professionally prepared meals. The Nutrition Unit developed the first airborne freezers and electric ovens especially designed for prepackaged frozen meals. These meals were designed to meet the unique requirements of long term confinement in pressurized compartments on high altitude missions. The survival rations were completely revised to provide more nutritional support under long term emergency conditions. The advent of the B-36 and the nuclear powered airplane brought the nutrition program and the associated equipment development activity to a high state of activity. The results of this work became the basis for the NASA nutrition and feeding equipment development programs (Mr. Chatham, RDO 691, Miss Finkelstein, 7164, 1946-1959)

Human engineering design principles and procedures for future ATC systems were being developed. A study using computer simulation indicated that when the identity of each target was provided on ATC radar displays, system performance under high work load conditions improved significantly. When target altitude information was added on an auxiliary display, a decrease in communication lead time occurred. When the number of controllers in a radar approach control center was increased a more complex traffic situation was accommodated (Dr. Queal, 7184, 1954)

Protective flight equipment and survival equipment usually totally enclosed the human body. This situation made the development of a body ventilation garment a key element in these protective equipment research programs. Dr. Hans Mauch, Chief, Environmental Section, was responsible for the development of the first successful ventilated garment. It was a multilayered liner similar to long john underwear. The liner contained thousands of pinholes which permitted either air or liquid to flow through the garment. The system was hooked to an external blower. The garment cooled its wearer and also considerably reduced humidity by venting off the moisture of perspiration. A modification of this development was later used by NASA in the Mercury and Gemini pressure suits (Dr. Mauch, 7164, 1954)

One of the most important functions of the Laboratory was preparing handbooks for Training Command, Operating Commands, aircraft manufacturers, and other ARDC laboratories, medical departments of the three Services and educational and private research institutions.

- Psychology Research on Equipment Design (Dr. Fitts, E. O. 694, 1947)
- Handbook on Training and Training Equipment Design (Dr. Eckstrand, RDO 694, 1953)
- A Human Engineering Guide to Equipment Design was prepared for use by design engineers. This was part of a joint Army, Navy, Air Force project (Dr.Grether, Dr.Warrick 7184, 1954)
- In cooperation with the National Academy of Sciences and the Federation of American Societies for Experimental Biology, the Handbooks of Biological Data were originated. These fifteen volumes contain the most complete and authentic collection of quantitative information concerning the composition, structure and functioning of living things ever assembled (Dr. Heim, 7164, 1956)
- A handbook on Vision in Military Aviation was used as the design standard for military aircraft (Colonel Emerson, 7157, 1957)
- A Handbook of Acoustic Noise Control that summarized the state of our knowledge pertaining to aircraft and power plant noise was completed (Dr. Parrack, 7231, 1958)

The limits of human tolerance to deceleration were defined in terms of rate of onset, magnitude, and duration for a stable flight system in a transverse G field. The curves describing the limits were divided into three zones: a zone of safety, a zone of probable disablement, and a zone of collapse or fatal injury. The zone of probable disablement had a lower limit established by a curve with a rate of onset of 1000 G per second to a maximum of 30 G with an exponential decay from this peak through 9 G at 10 seconds. The dividing line between the zone of probable disablement and zone of collapse was established as a line with a rate of onset of 1500 G per second, peaking at 35 G with an exponential decay through 11 G at 10 seconds. Using this information for engineering design work, a milestone in biodynamic research was reached at the SMART track in November 1956. Three separate rocket sled tests with open ejection seats and chimpanzee subjects were successfully accomplished. The animals were recovered alive following ejection at velocities approaching MACH 1 (Major Hessberg, 7222, 1956)

Two partial pressure altitude suits were developed in 1956 the (MC-3) for bomber aircraft and the (MC-4) for fighter aircraft. They provided improved time-at-altitude capabilities for the crewmember. In conjunction with an improved pressure helmet and oxygen regulator, these suits had bail out oxygen provisions and anti-g capability. As a result of these improved suits and helmets, all previous pressure suit equipment was classified as "Limited Standard" (Captain Vail, Mr. Rosenbaum, 7164, 1956)

An early effort recognizing the significance of increasing costs of ownership for weapon systems produced the first of a series of maintainability design guides, Guide to Design of Electronic Equipment for Maintainability (Dr. Eckstrand, 7150, 1956)

Tactical use of jet aircraft required a capability for high speed, very low altitude flight. Under these flight conditions, buffeting, caused by turbulence in the atmosphere, had become a serious problem. To study the effects of buffeting this Laboratory developed a "vertical accelerator" which could be programmed to simulate the vertical component of accelerative forces (in the frequency range from 0-10Hz with maximum peak-to-peak displacement of 20 feet) to which aircraft personnel were subjected in turbulent atmosphere. This simulator was delivered and, following completion of its assembly, studies were carried out to determine the physiological and psychological effects of buffeting on aircrew performance. Results of these studies have been directed toward the protection of flight personnel and the establishment of buffeting tolerance criteria (Major Gannon, 7231, 1957)

Two human factors data specifications were published, one for missiles, and one for manned aircraft systems. Human engineering design standards were also prepared for contractor compliance in the Air Force Intercontinental Ballistic Missile program. These publications stimulated a major increase in human factors effort by weapon systems contractors (Mr. Ring, Dr. Topmiller, Mr. Greek, Mr. Bates, Captain Kibler, 7184, 1957)

Modification of the previously developed omnienvironmental suit and incorporation of the ventilated garment produced the first experimental full pressure suit. It was tested in the altitude chambers in June 1957. With additional minor modifications, this suit was adopted for use in the X-15 flight test program, and the X-15 escape system sled test program (Dr. Vail, Mr. Rosenbaum, 7164, 1957)

The first developmental plans for a nuclear powered aircraft indicated it would be a vehicle in the class of a B-36. That vehicle was to have a normal flight duration of 120 hours, using a crew of five men confined in a relatively small shielded crew compartment. The WS-125A System Program Office requested the Laboratory to conduct a research program on aircrew habitability. An investigation of the crew compartment facilities produced several areas where crew performance and fatigue would be affected by the long range and high performance aircraft requirements. The most critical area was the integration of crew members into a compartment that seriously restricted mobility, and required the aircrew to fly the aircraft continuously on instruments without outside visibility. Another area was the close crew scheduling which disrupted the individuals diurnal cycle and the overall crew diurnal pattern. A complete aircraft crew compartment simulator was constructed which incorporated principles, facilities, and subsystem concepts that were well beyond contemporary technologies. Five different aircrews participated in a typical 120 hour simulated flight. Integrated medical instrumentation of both the aircrew and the compartment recorded a complete picture of the functional efficiency of this man-machine system. The data from this program were provided to the WS-125A weapon

system program, and also published in technical reports as well as a book written by the Air University on the problems of nuclear flight (Mr. Dempsey, 7222, 1958)

The Aircrew Equipment Section conducted two full scale survival programs using human subjects in the B-58 emergency escape capsule. The first survival test was conducted in the warm tropical waters off Key West, Florida. The second survival test was conducted under winter conditions on land. The B-58 individual escape capsule was the first such device used in production military aircraft. The capsule eliminated the need for the aircrewman to wear heavy protective clothing during flight or escape. The capsule and its stored personal equipment was the only capability for human survival in an emergency condition. These crucial tests were directed to an evaluation of this new concept and to obtain information on changes or improvements which would be identified by these realistic tests under actual field conditions. Medical and field instrumentation provided data on the occupant's physical condition during the prolonged habitation on the water. It also provided data about the frequency, roll rate and amplitude of the motion produced by the flotation characteristics of the capsule. Finally the habitable conditions inside the capsule were recorded to establish the need for specific types of survival equipment and their packaging requirements (Mr. Huey, 6373, 1958)

The need for highly autonomous (intelligent) weapons and control systems led to a systematic investigation and modeling of those structures of the nervous system which are responsible for "intelligent" behavior. This ambitious "Bionics Project" was a joint program between the AMRL and the Avionics Laboratory, which were both at this time parts of the Wright Air Development Division of AFSC. Primary objects of these investigations were the mechanisms for such functions as pattern recognition, automatic speech recognition, scene analysis, and sophisticated control algorithms for multiple degree of freedom goal oriented systems. The AMRL had one of the first limited vocabulary word recognition machines, and prototypes of other pattern recognition devices were developed. The Bionics program prepared much of the foundation for work presently continuing under the name of "Artificial Intelligence." (Dr. von Gierke, Dr. Oestreicher, Colonel Steele, 7231, 1958)

A maintainability research program emphasizing development of human engineering design criteria for both ground and space maintenance operations was initiated. Concerns included design of job aids, remote manipulators, automatic check-out equipment and maintainability prediction (Captain Pigg, 7184, 1958)

FIRST ORGANIZED AEROMEDICAL RESEARCH ON MANNED SPACE FLIGHT

In 1957-1958, Colonel Don Flickinger designated the Aerospace Medical Research Laboratory as the fundamental focal point for the then new USAF initiative, MAN IN SPACE. The Laboratory staff and division chiefs were organized into a comprehensive technical/management team to create a major technical initiative to develop the aero medical information necessary for the engineering design of a manned vehicle for low earth orbital flight. A project, "Physiology of Space Flight," was organized to implement the requirement for techniques, equipment and knowledge to operate manned space vehicles with maximum effectiveness and safety. The tasks included were

- Human thermal stress in space environment
- Physiological criteria for space environments
- Personal protection for astronautical operations
- Nutrition in space flight
- Visual problems in space environment
- Development of materials for personal protection
- Systematization of biological knowledge

A working protoype of a closed circuit breathing and ventilating system was developed. This system provided the oxygen supply, carbon dioxide absorption capacity, and cooling necessary for one man flying a 12 hour mission. The system was smaller and weighed less than available equipment. It had the capability to operate in a zero-G field (Mr Roundy, 6373, 1958)

An industrial hygiene program for missile bases was developed to ease military and civilian concern about the new rocket propellants toxic properties. Surveys were made of potential hazards, handling procedures, and preventive remedial measures were formulated (Major Westlake, 7164, 1958)

The problem of human performance under conditions of weightlessness required a new approach to gather research data. A C-131 aircraft was modified into an airborne facility and a flight maneuver was developed to produce fifteen seconds of true weightlessness. This flying laboratory permitted human performance research under reduced G conditions. The work included control manipulation, human locomotion, body control, use of personal propulsion devices, orbital transfer, and performance of maintenance and assembly tasks (Captain Simons, Major Brown, 7184, 1958)

NASA requested the Laboratory to determine if a man could tolerate certain acceleration patterns anticipated in the mannned flights into orbit and return. Human subjects supported on a net couch were tested for tolerance to an acceleration profile of 16.5 G. The MC-2 pressure suit was worn during tests to see if it impaired tolerance. Subjects were able to perform finger-tip control during all but the peak phases of acceleration (Captain Clarke, 7222, 1958)

Research was conducted on human tolerance and performance under severe vibration and transient acceleration conditions. The mechancial shake table with a 4.5 inch displacement and a vertical accelerator with a 10 foot displacement were used in the study of human tolerance to sinusoidal vibration from 0 to 15 cps. These low frequencies were possible for the first time because of large displacement capability (Captain Hansen, 7231, 1958)

Extensive studies of the noise generated by rockets and tests on several means of modifying rocket noise led to important new knowledge in that field. The rocket data in conjunction with additional analysis of turbojet noise fields, measured previously, made possible the formulation of a scheme to predict noise fields fairly accurately from a knowledge of the engine parameters. These, plus other data, also led to a method for evaluating the noise problems of a given air base without having to make measurements on the spot (Mr. Cole, 7231, 1958)

Research was conducted on maintenance training, especially optional features of automatic tutoring devices and on ways to isolate the significant intellectual aspects of maintenance operations. Space flight necessitated research on the conditions influencing reliable performance of operators despite unavoidable physical and emotional stress (Dr. Eckstrand, 1710, 1958)

AWARDS

1947	Captain Stapp	Legion of Merit
1948	Dr. Berner	Exceptional Civilian Service Award
1949	Mr. Good	Exceptional Civilian Service Award
1952	Mr. Seeler	IAS Thurman H. Bane Award
1953	Dr. Grether	Longacre Award
1954	Captain Sperry	Distinguished Flying Cross
1954	Colonel Henderson	Distinguished Flying Cross
1954	Sgt. Post	Distinguished Flying Cross
1954	Lt. Neilsen	Distinguished Flying Cross
1955	Captain Sperry	Cheney Award

Fig III-1 Wright Field on October 21, 1946.

Fig III-2 Lt Col. Paul Fitts, Founder Psychology Branch

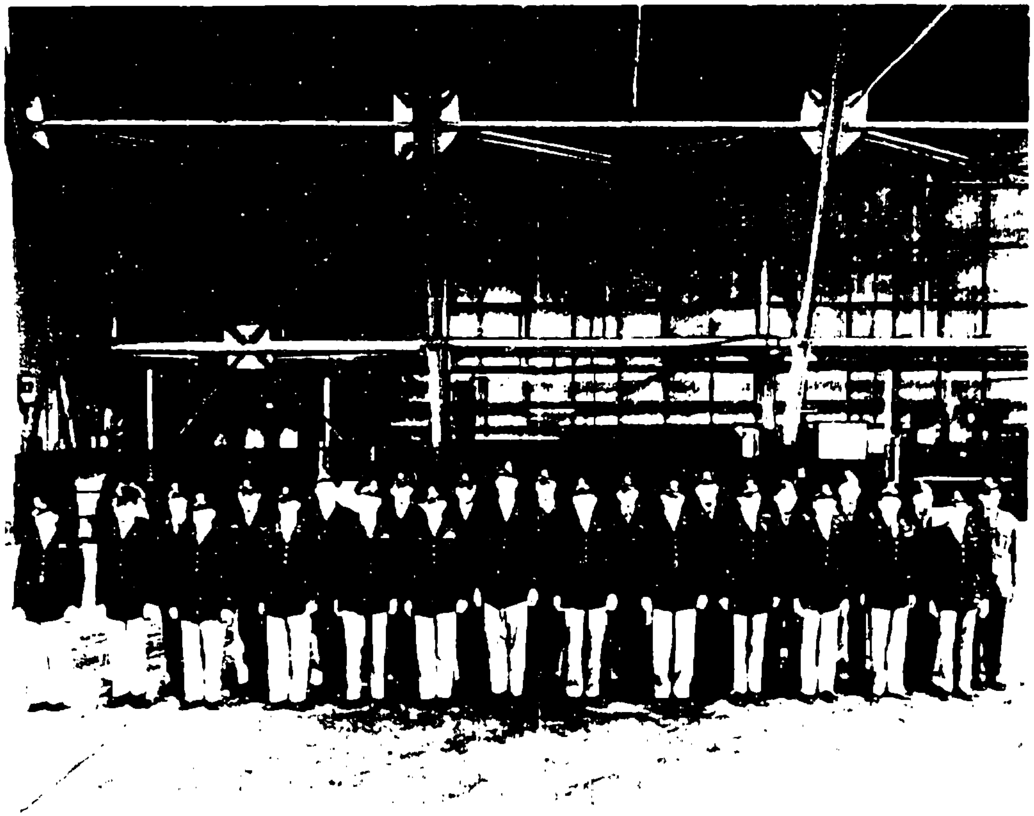


Fig III-3 Officers assigned to the Laboratory, 1946.

2nd Row
Unknown, Unknown, Major Simons, Unknown, Unknown, Unknown, Unknown, Unknown, Unknown, Unknown, Unknown, Unknown.

1st Row
Captain Maher, Unknown, Major Sweeney, Major Pinson, Unknown, Colonel Kendircks, Lt/Col. Gagge, Unknown, Unknown, Unknown, Unknown, Unknown, Unknown.

8th Row
Don Penrose, Julien Christensen, Horace van Saun

7th Row
Fred Tressler, Larry Campbell, Paul Ritter, Glen Finch, John Wilson, Alexander Byroff, James Peskin, John Sullivan.

6th Row
L. Smith, John Hall, True Robinson, Dick, Harold Carr, Betty Stein.

5th Row
Harold Lichty, Charlie Lutz, Whalen Hull, Harvey Savely, Victor Guillemin, Josh Chatham, Calra Zuern, Polly Brett.

4th Row
Al Herald, Irv Lanta, Ed Shinabarger, Woody Draper, Paul Galloway, Don Huston, Genevieve, Myrtle Parkinson.

3rd Row
Clyde Roach, Joe Best, Mac McCoy, Bob Roettele, Frank Gerard, Harmon House, Henry Dotts, Rey Middleton.

2nd Row
Charlie Wilde, Ward Bice, Ray Whitney, Bob DuBois, Don Good, Earl Parker, Elia Timmons, Ray Fuller, Neil Zollars.

1st Row
Virgil Cartwright, Bill Burgess, Ann Parker, Joe Bakalus, Curt Musgrove, Charlie Castellano, Ed Hertzberg, Marguerite Knorr, Francis Moyer, Winnie Wilde, Mae Callen

Fig III-4 Civilians assigned to the Laboratory, 1946.

Fig III-5 *Personnel assigned to the Psychology Branch.*

Back Row
Lt. Wise, Mr. Bakalus, Mr. Gardner, Miss Fuerst, Mr. Roettele, Miss Connell, Mr. Warrick, Mrs. Morris, Mr. Christensen, Msgt. Kake, Sgt. Edison, Mr. White.

Front Row
Capt. Jones, Major Long, Dr. Fitts, Dr. Grether, Dr. Biel, Capt. Wilcox

Fig III-6 Dr. Christensen conducting a human engineering experiment, 1946.

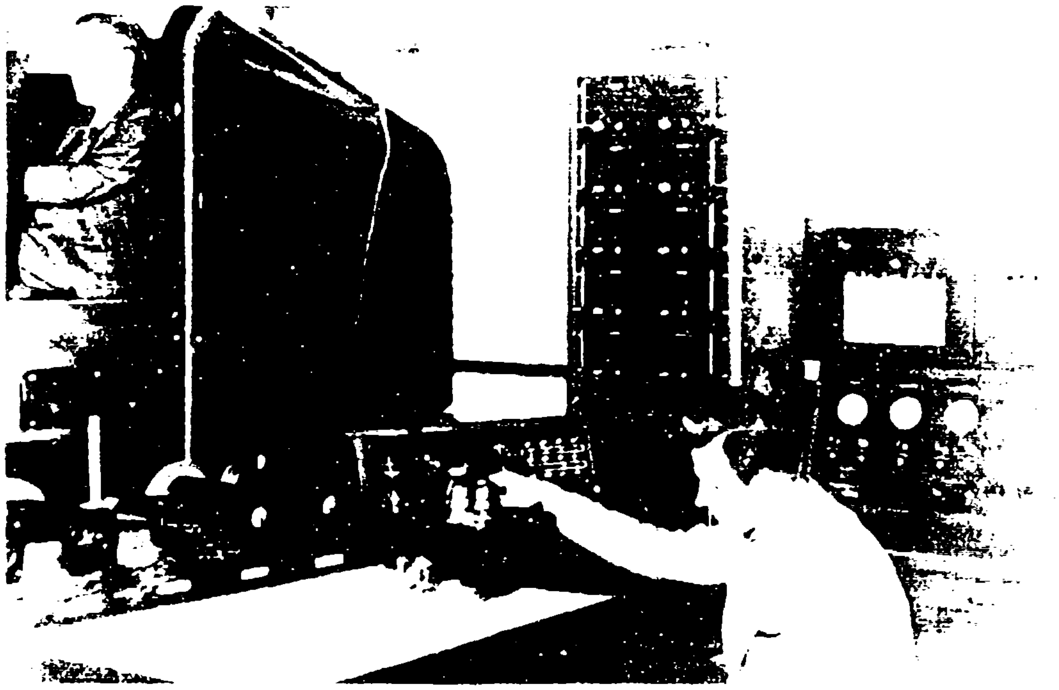


Fig III-7 Dr Grether and John Gardner conducting an experiment in the Link trainer.

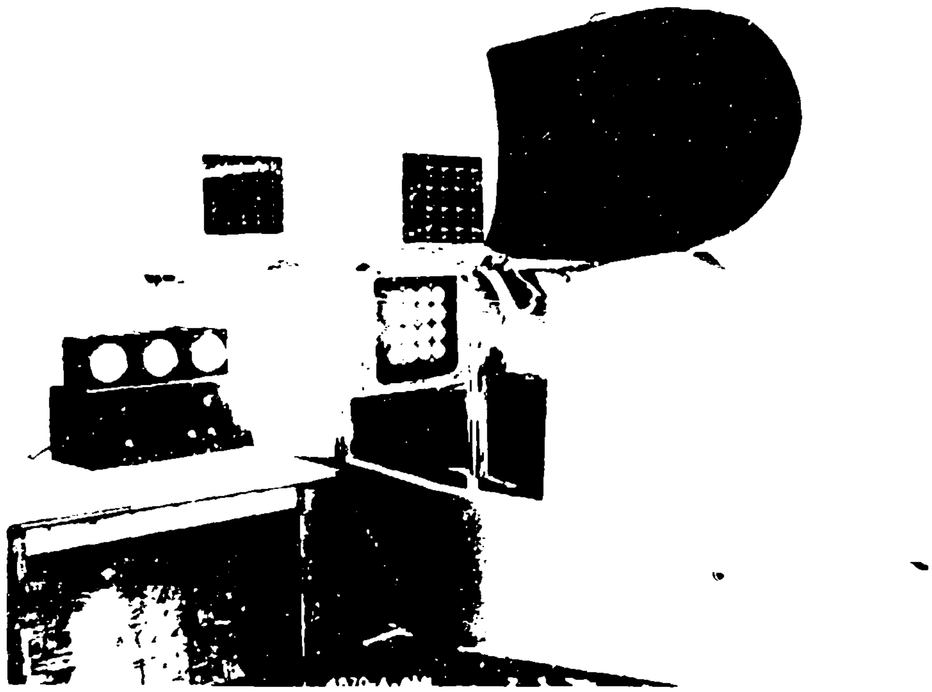


Fig III-8 Link trainer used in human engineering research on cockpit instrument design and arrangement.

Fig III-9   Human engineering experiment on the development of horizontal pointer alignment for aircraft powerplant instruments

Fig III-10 Experiment in the development of shape coding of aircraft cockpit controls.

Fig III-11 Psychology Branch airborne laboratory (C-47)

Fig III-12 Electronic scoring equipment located in the main cabin of the C-47.

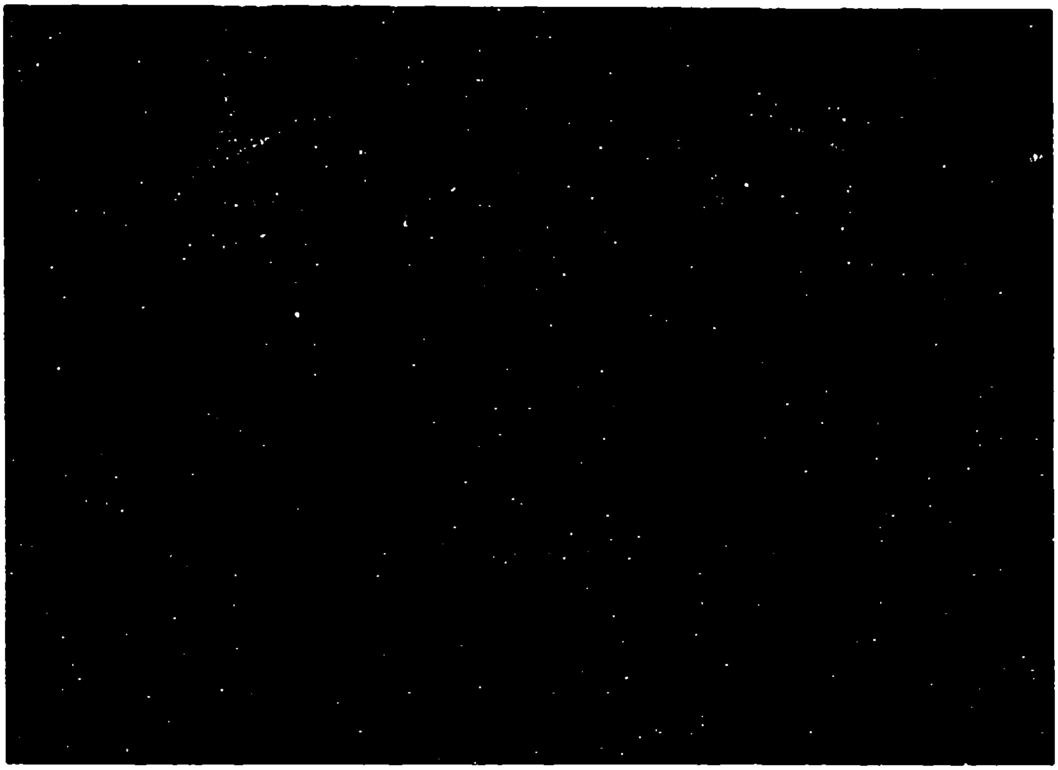


Fig III-13 Cockpit of the C-47 airborne laboratory in which new concepts for cockpit design were extensively tested and scored in flight. This pioneering research established the new Air Force standard for future cockpit design and was incorporated in the Handbook of Instruction for Aircraft Designers (HIAD).

Fig III-14 Aerobee rocket flight package which carried the first two monkeys and two white mice on high altitude ballistic flights (1948-1951).

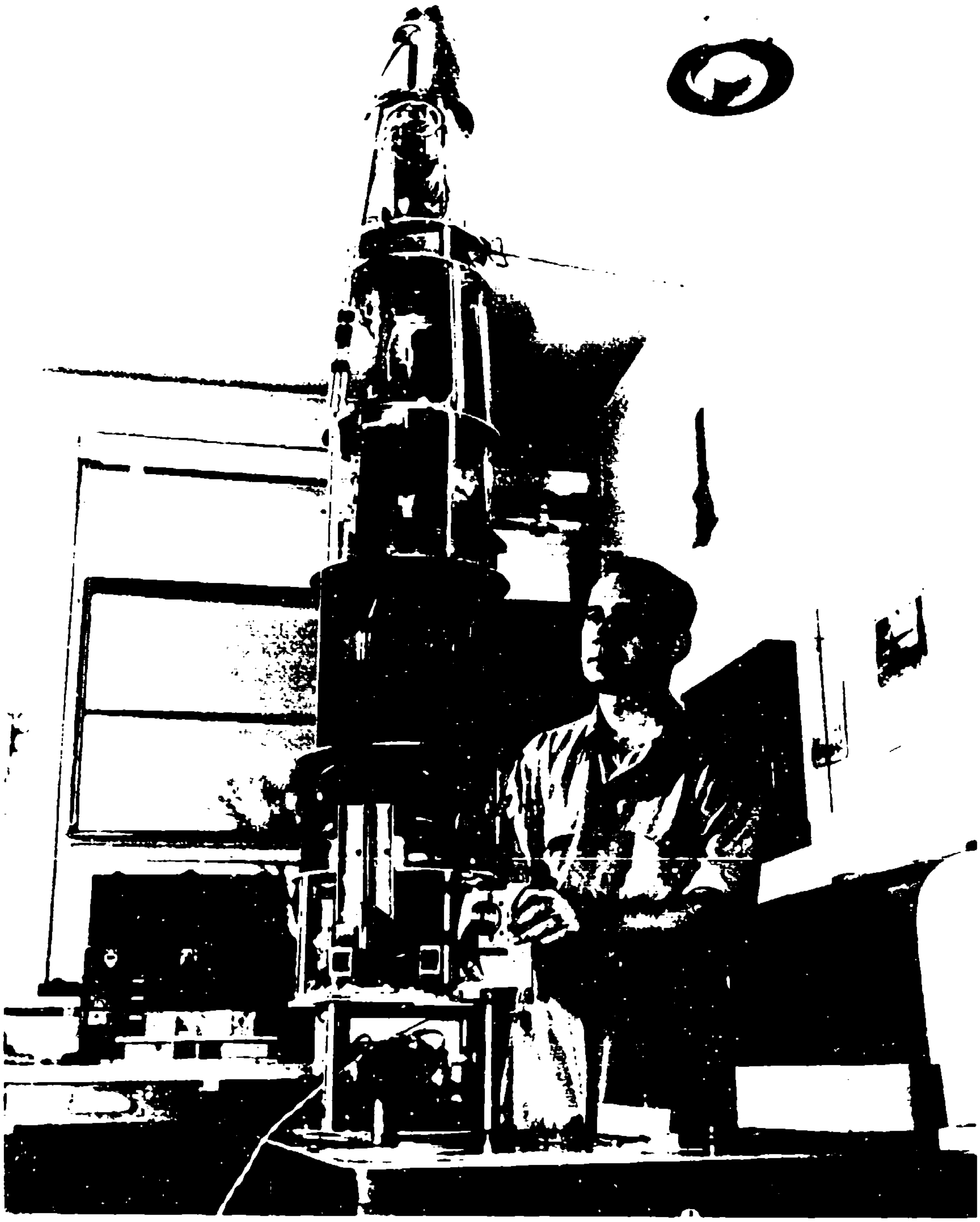


Fig III-14A Mr. Eric Gienapp and the Aerobee flight package the designed and constructed in the Laboratory.

Fig III-14B The AMRL project team which conducted the Aerobee rocket flights.

Unknown, Miles McLennan, Unknown, Ed Correll, Harold Childers, Eric Gienapp, Unknown, Jim Henry

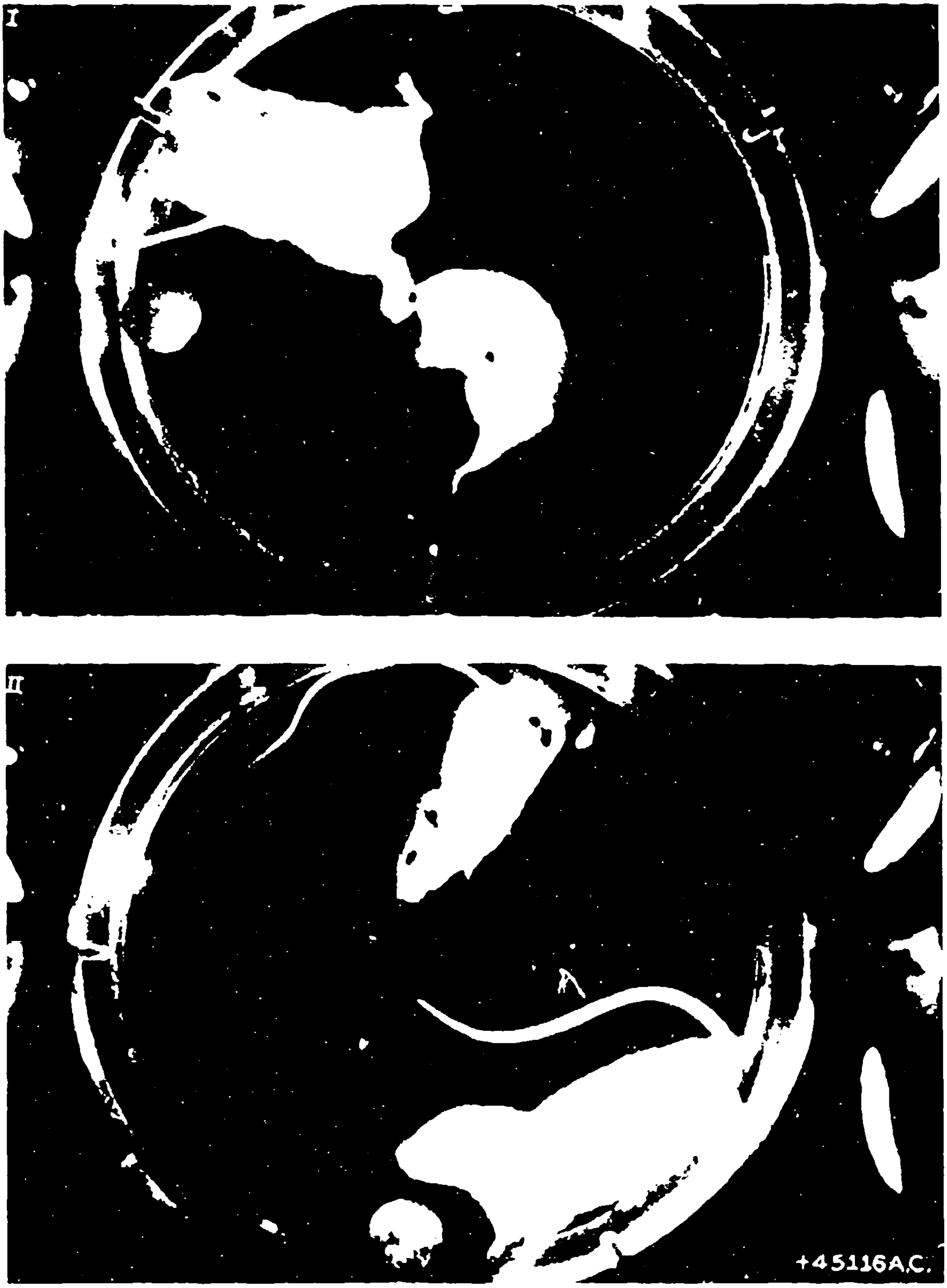


Fig III-45   Two white mice in zero G environment during Aerobee rocket flight to 36 miles altitude

Fig III-15A Aero Medical Laboratory project personnel and AMRL B-17 #5570 used in the Aerobee project.

2nd Row
Unknown, Ed Correll, Unknown, Harold Childers, Unknown, Ed Ballinger, Eric Gienapp

1st Row
Unknown, Vince Mazza, Unknown, Unknown.

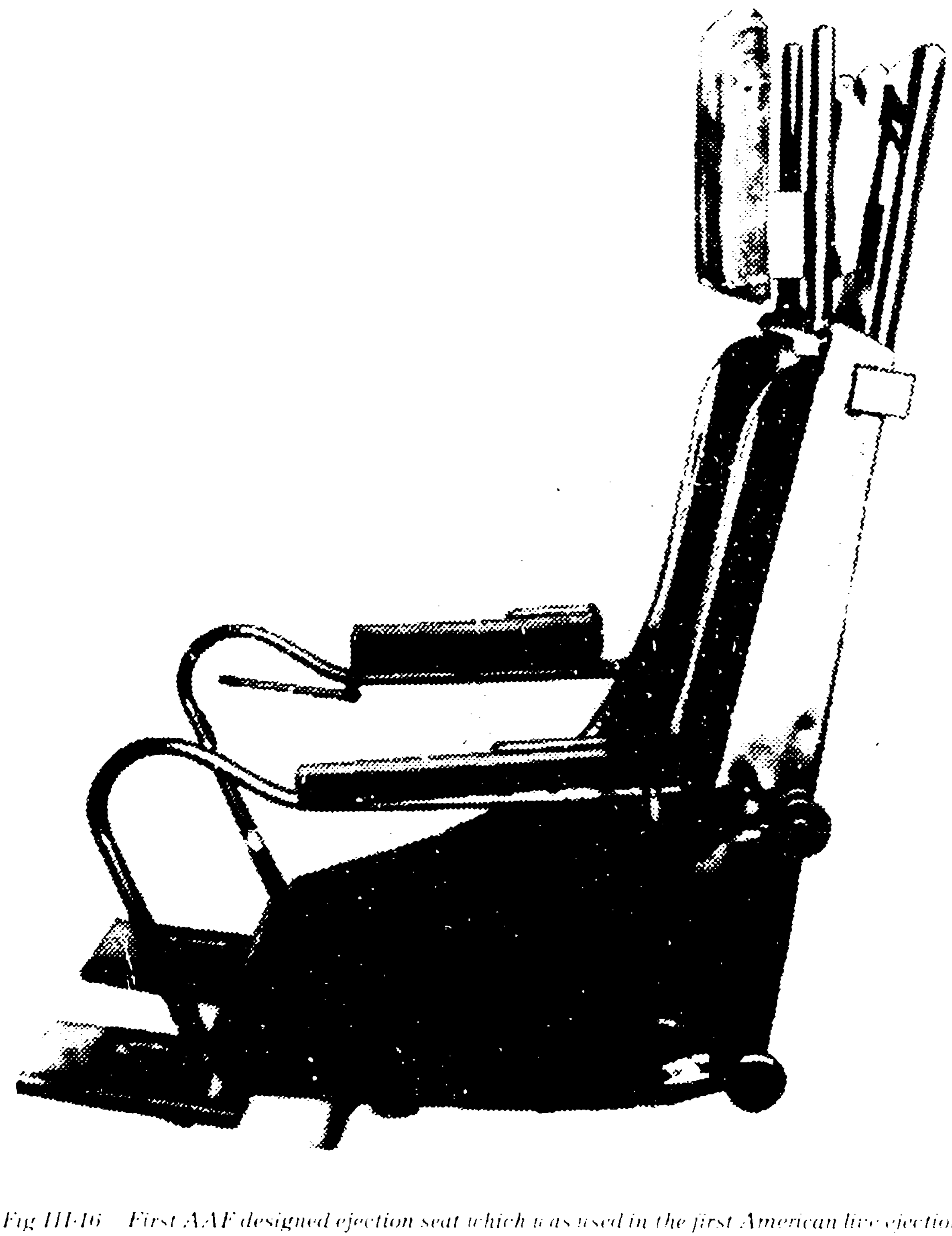


Fig III-16   First AAF designed ejection seat which was used in the first American live ejection tests.

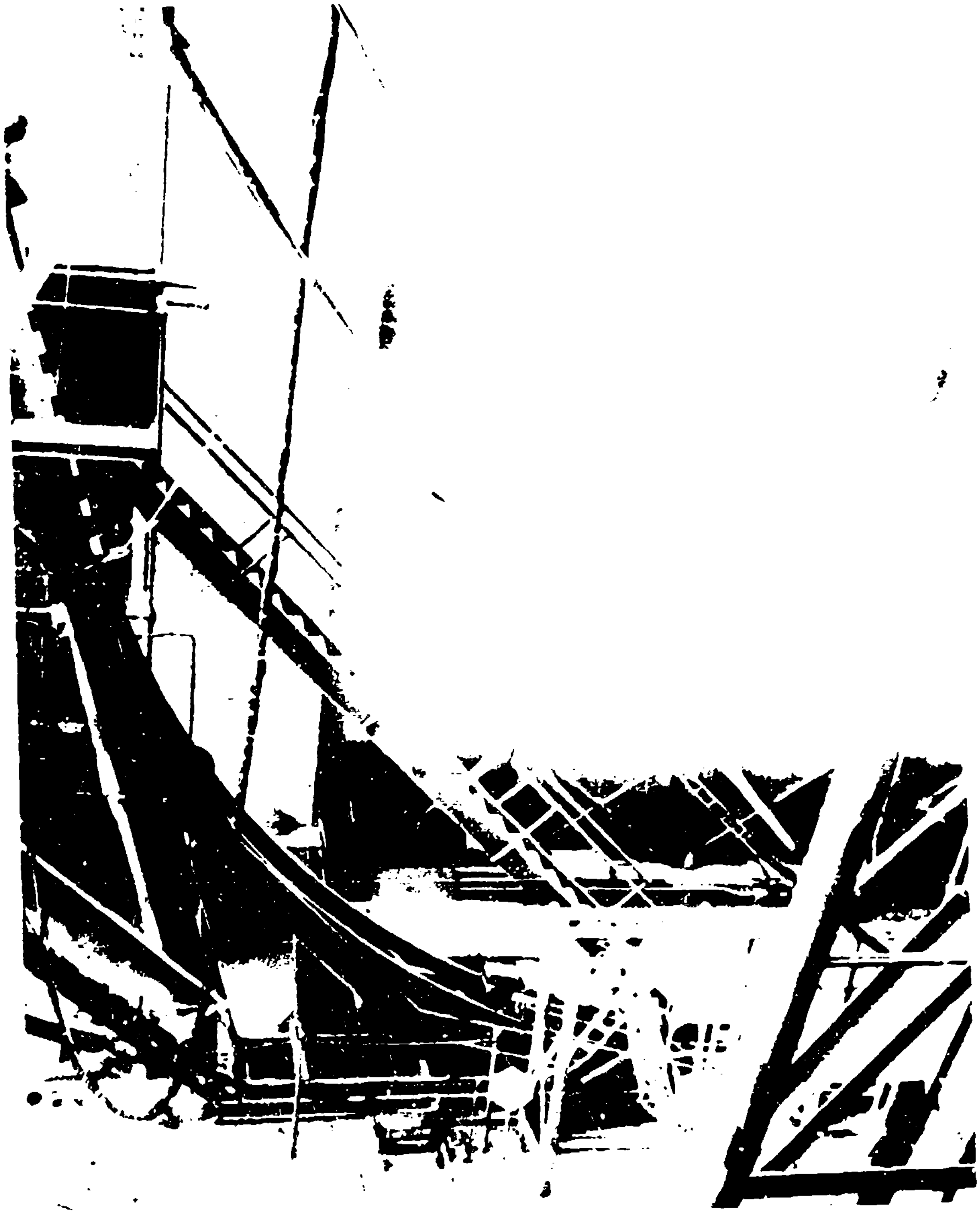


Fig III-17 The first downward ejection tower, used in the development of the new downward ejection seat.

Fig III-18 The 100 foot upward ejection test facility located in Bldg. 65.

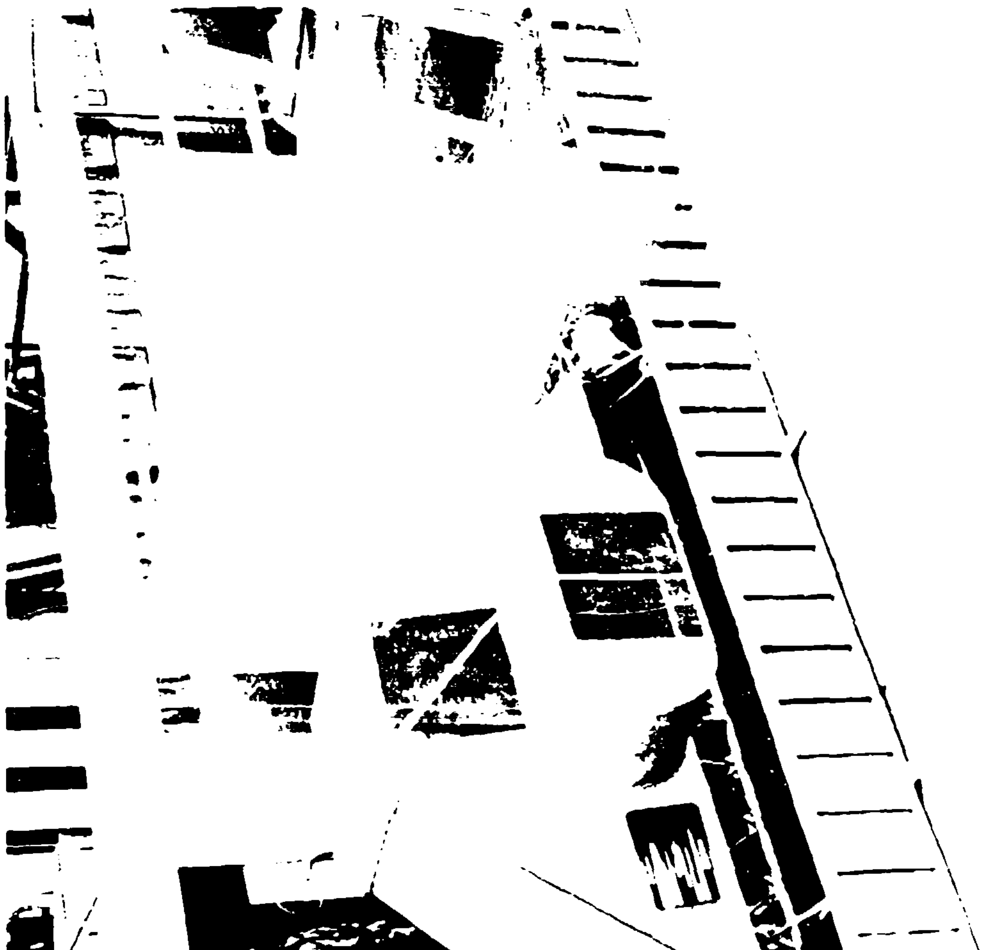


Fig III-19 The first rocket sled built for the pioneering human deceleration tests at Muroc Air Field.

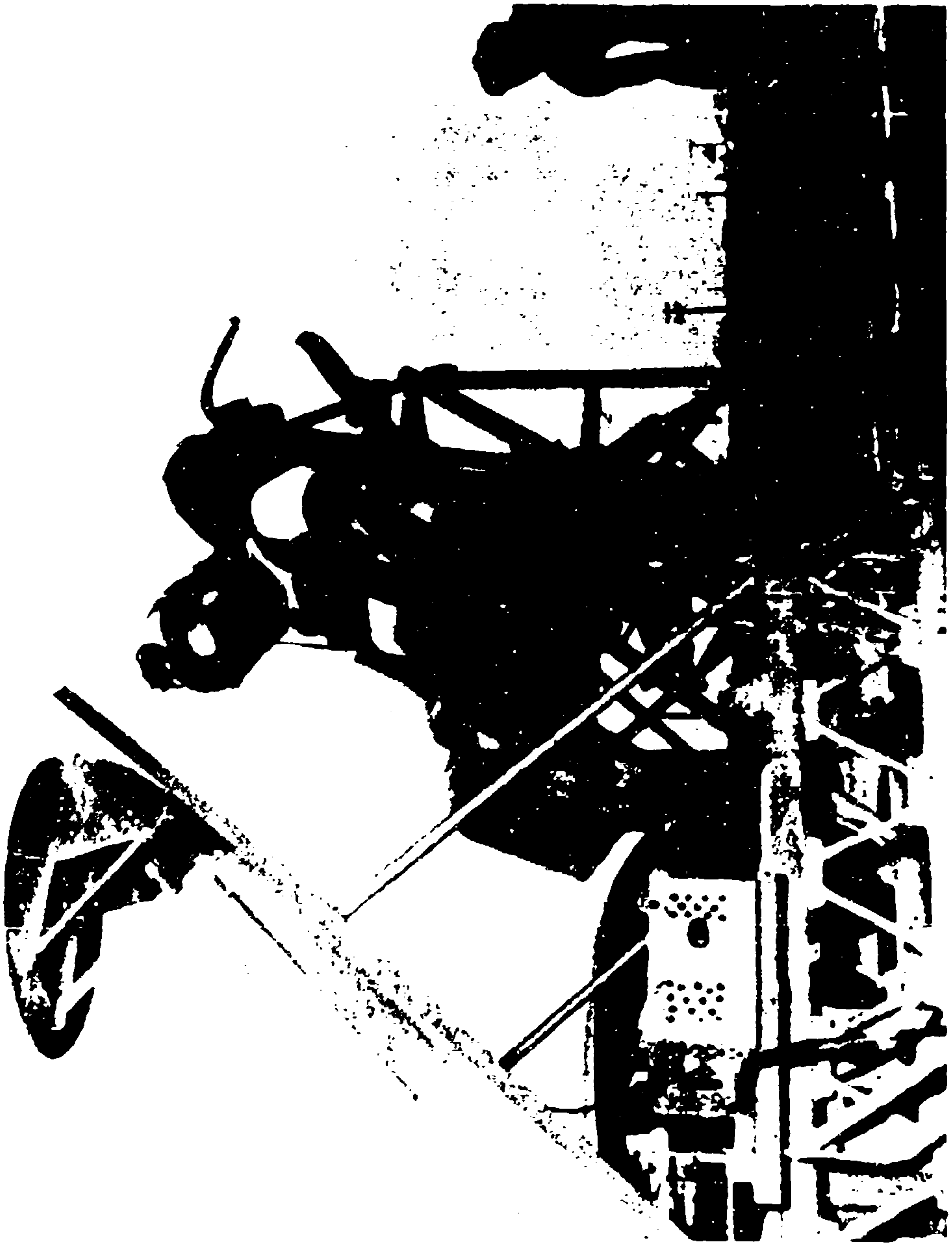


Fig. III-20 Major John Stapp on the second rocket sled built for human deceleration experiments at Holloman AFB.

Fig III-21 Colonel Henderson being dressed by Lt. Sperry for the first human test of the new downward ejection seat in the B-47.

Fig III-22 Lt. Neilsen after downward ejection experiment from a B-47. Lt. Neilsen has a broken shoulder. Colonel Henderson is seated on his left.

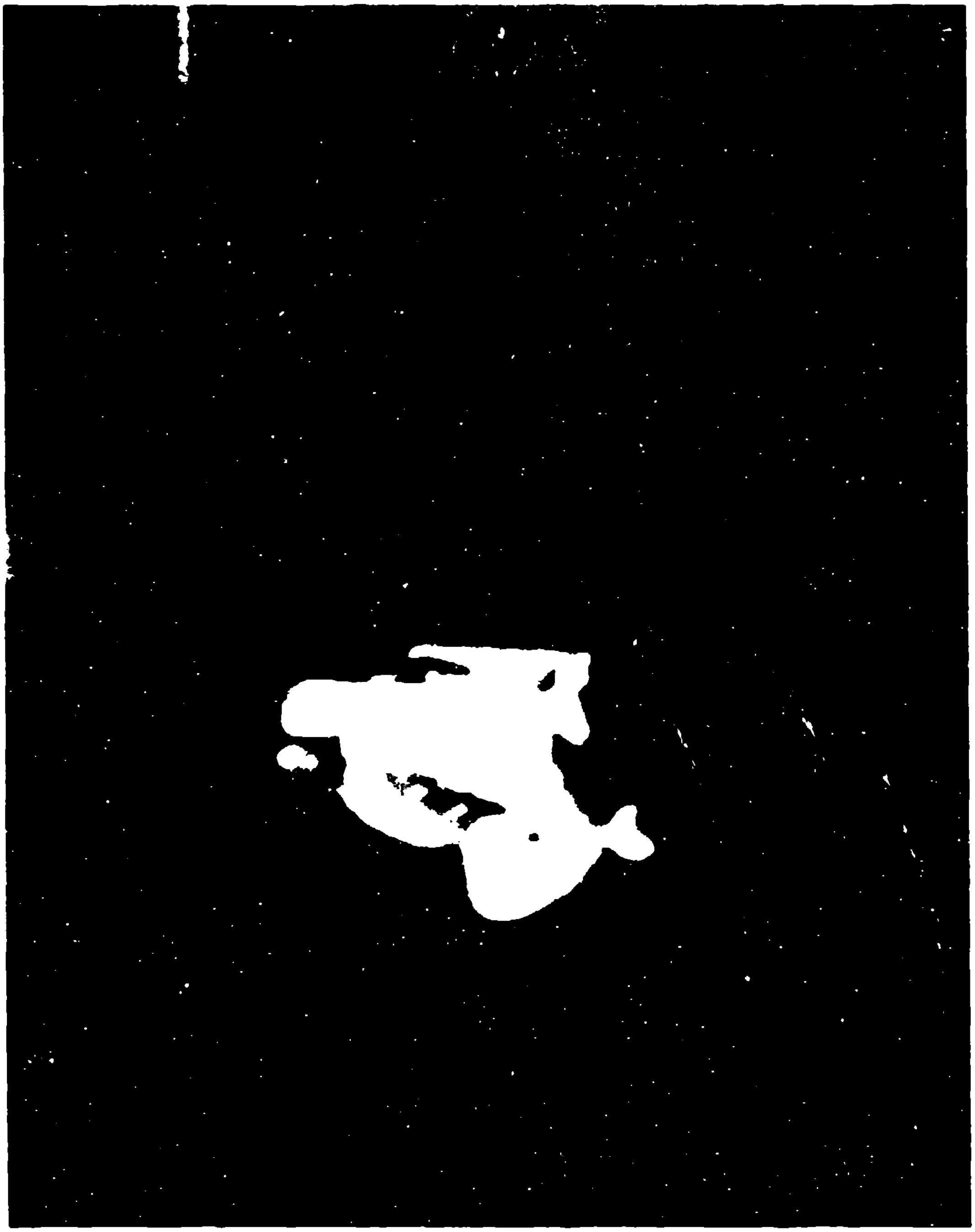
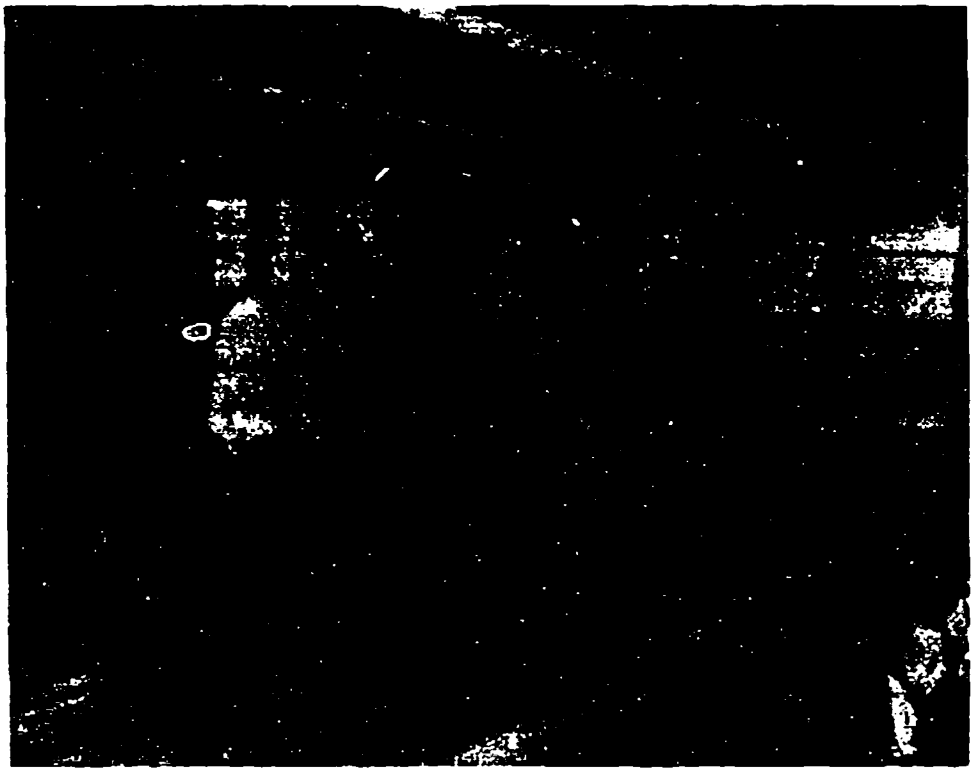


Fig III-22A Live downward ejection test from the B-47.

Fig III-22B First American high speed live ejection test.



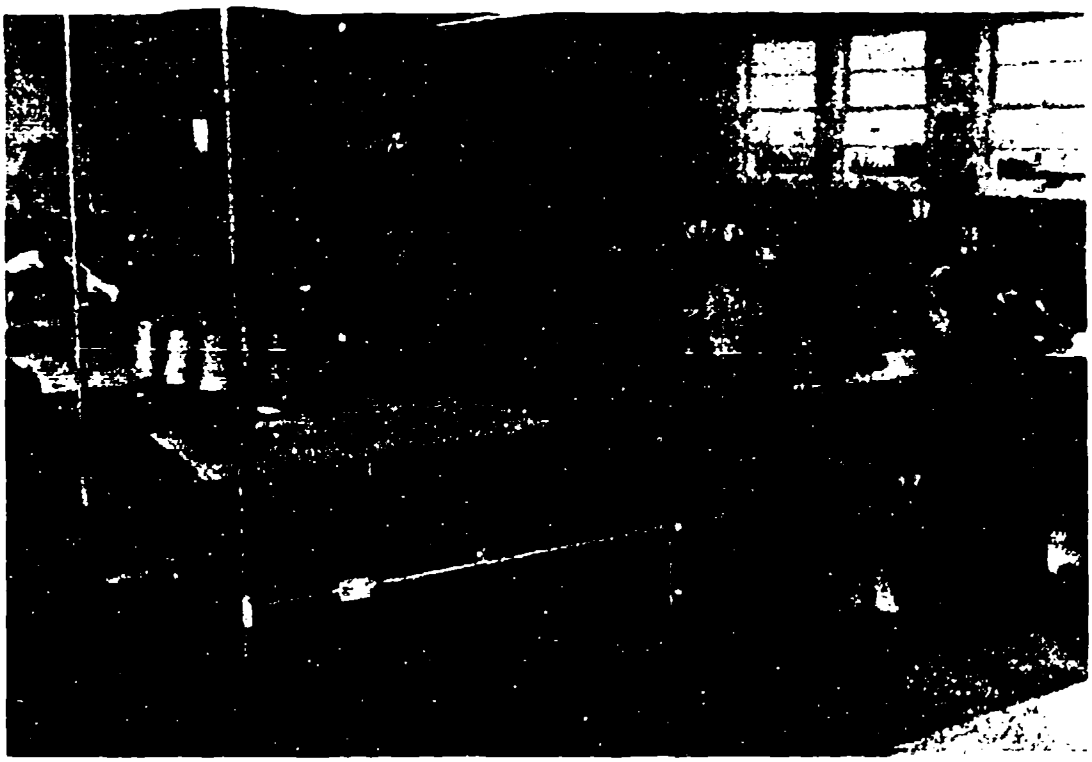


Fig III-23 The production area of the Clothing Branch. All USAF experimental uniforms and flight clothing were fabricated in this facility.

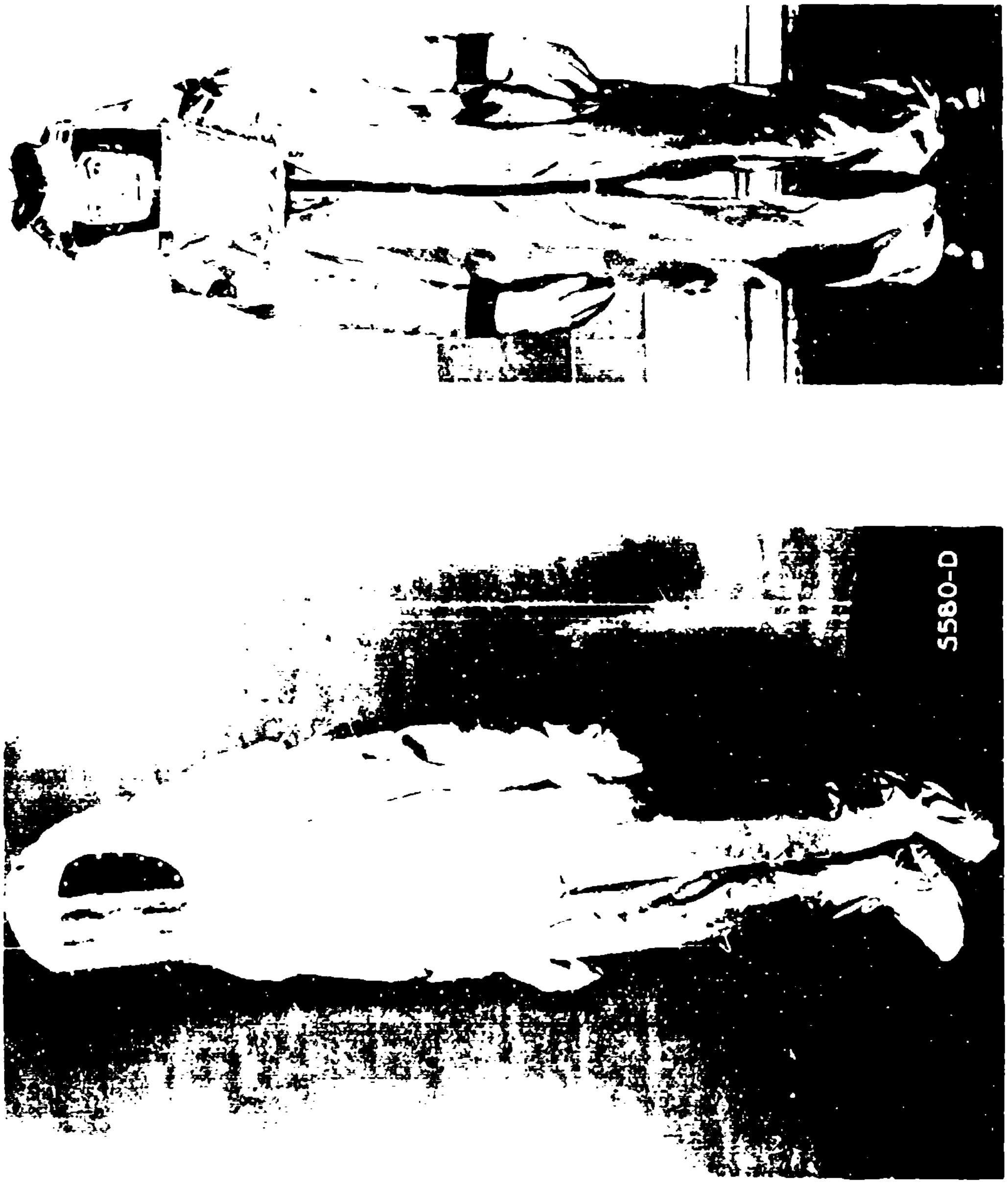


Fig III-24 Fire fighters thermal protection suits designed by the Clothing Branch.

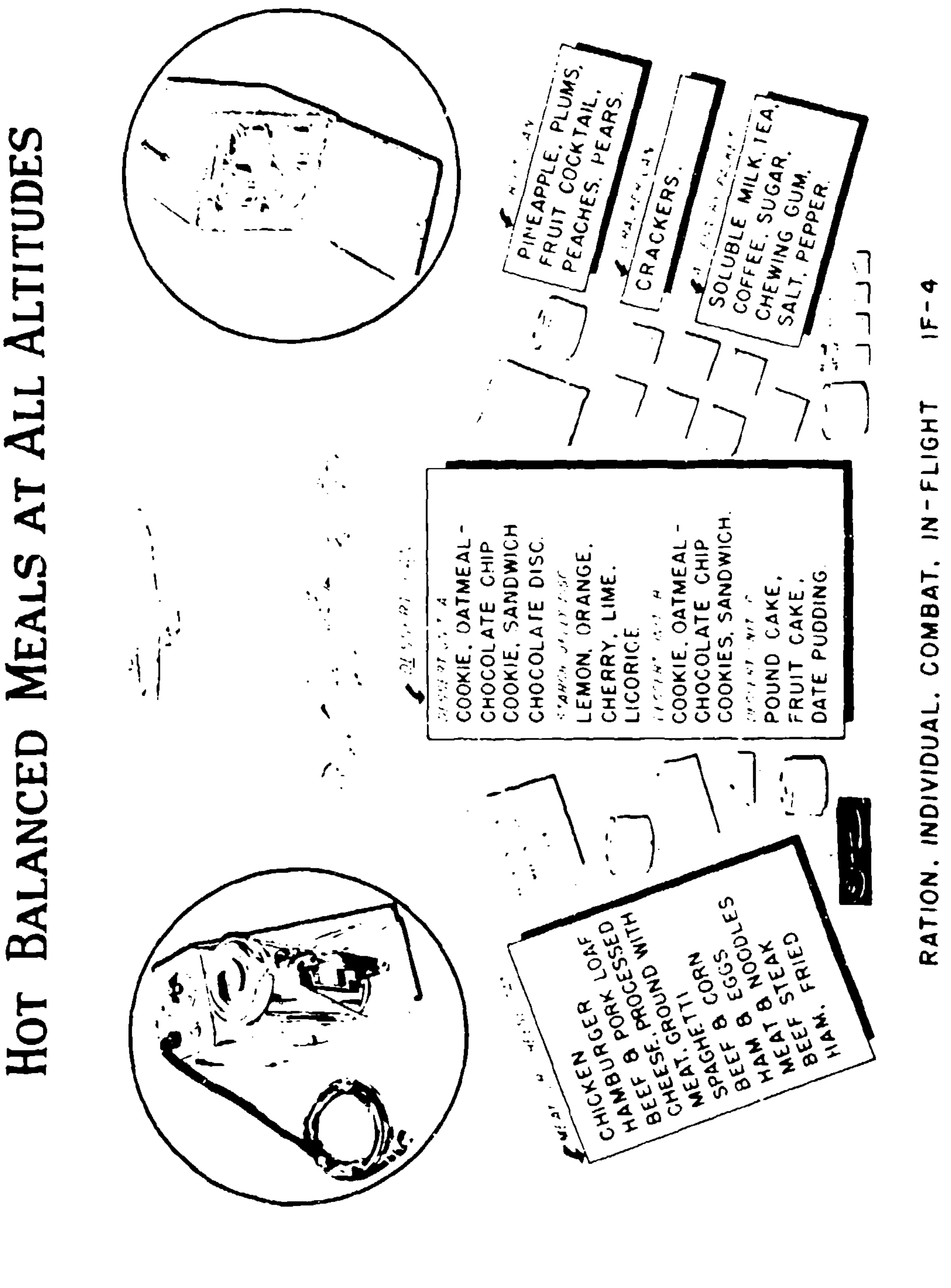


Fig III-25 Individual in-flight combat meals for use in multiengine aircraft with food warming ovens.

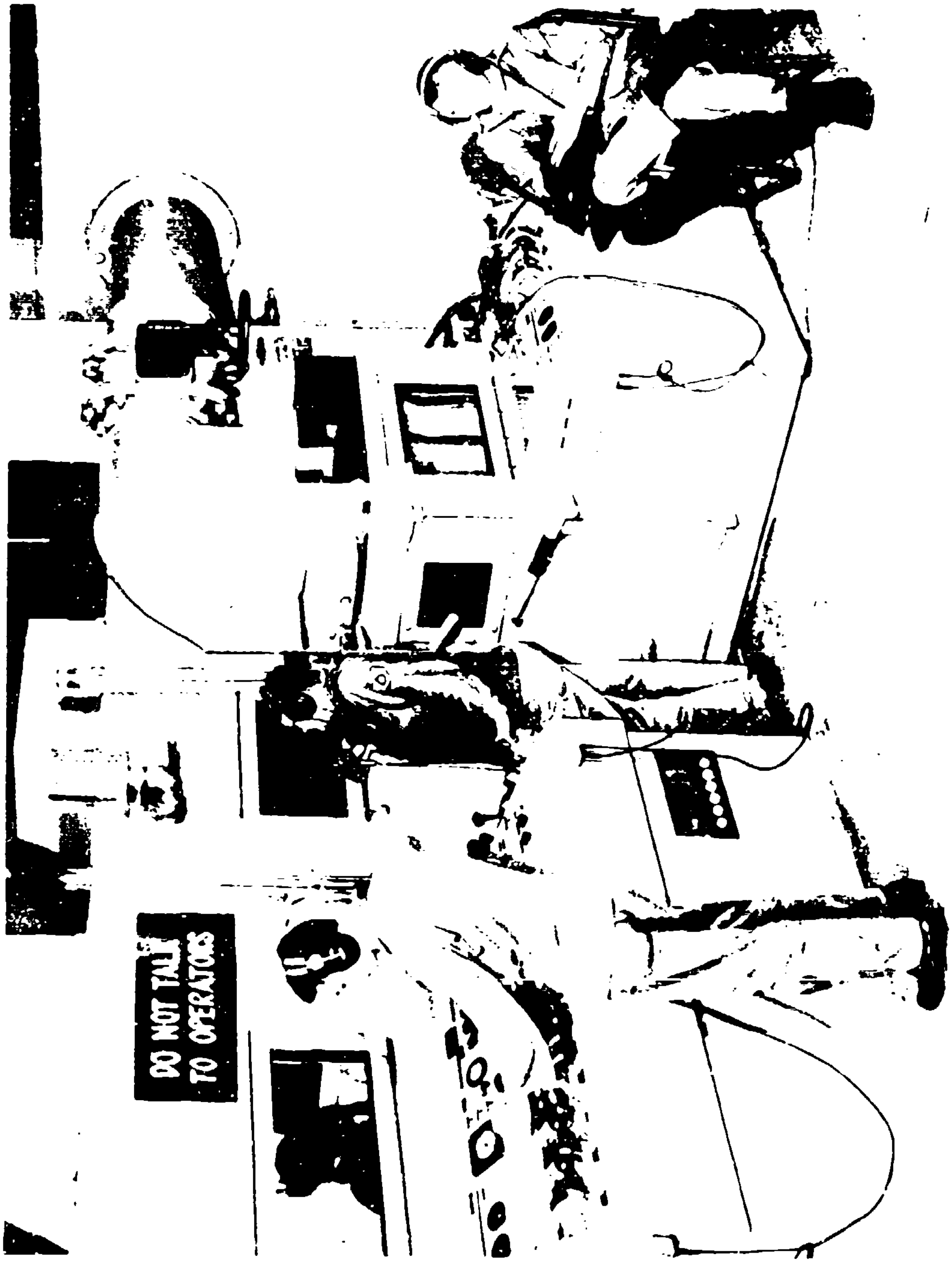


Fig III-26 Altitude chambers in the basement Bldg. 248. These chambers were used for the development of first operational full pressure suit (X-15).

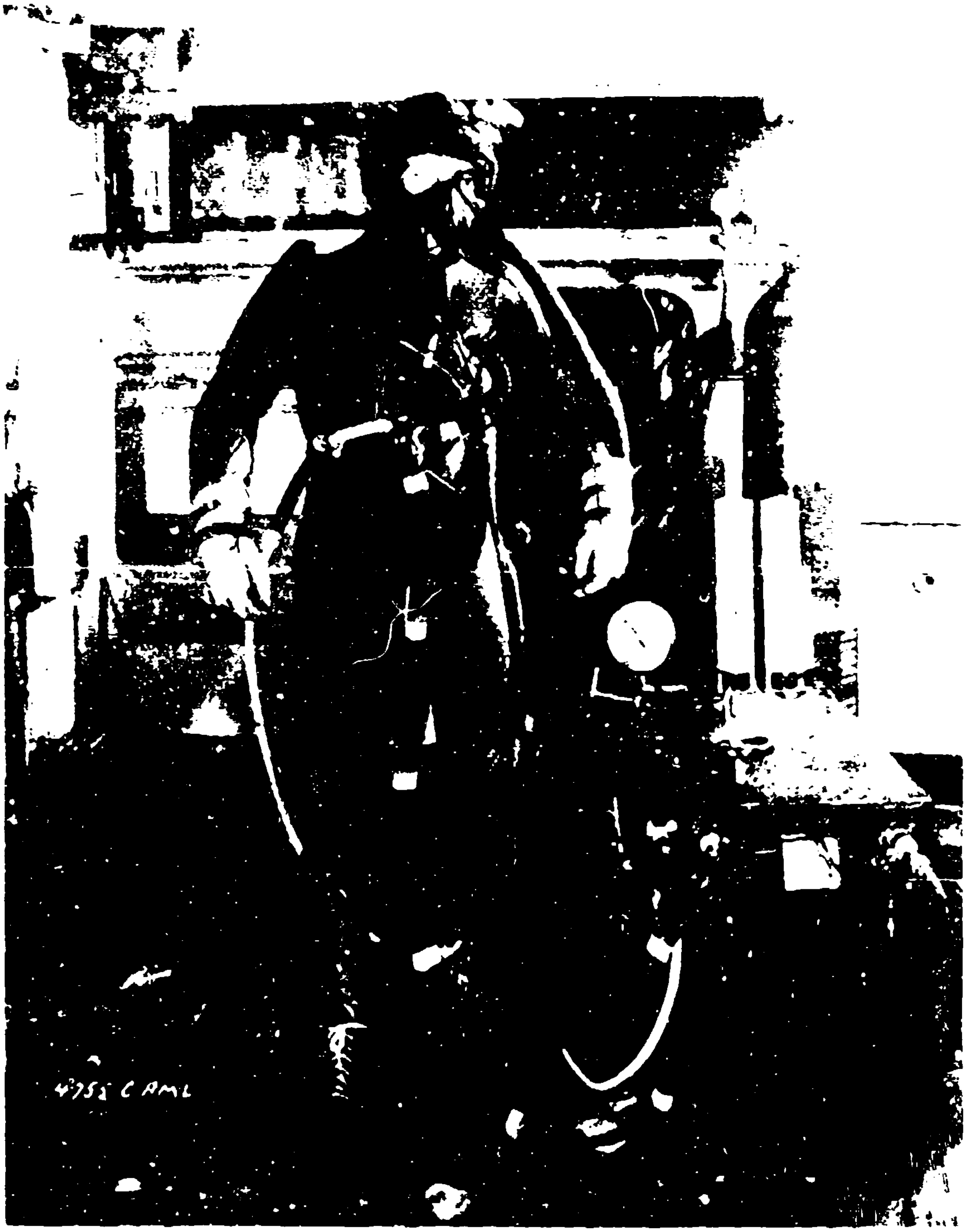


Fig III-27 The S-1 partial pressure suit was developed by Dr. Henry. It was standardized in 1953

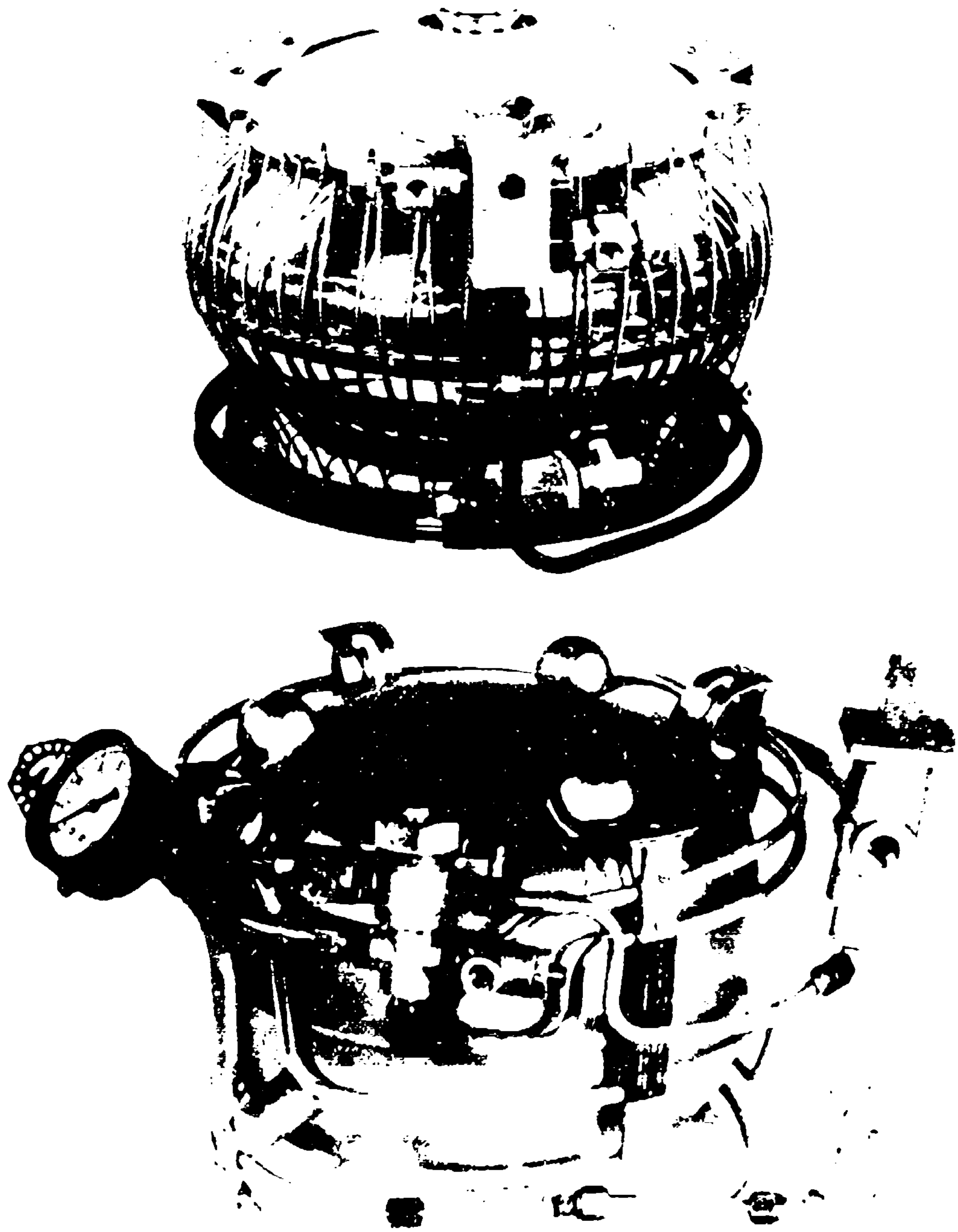


Fig III-28   The first operational liquid oxygen system for jet fighter aircraft. Five liter converter.

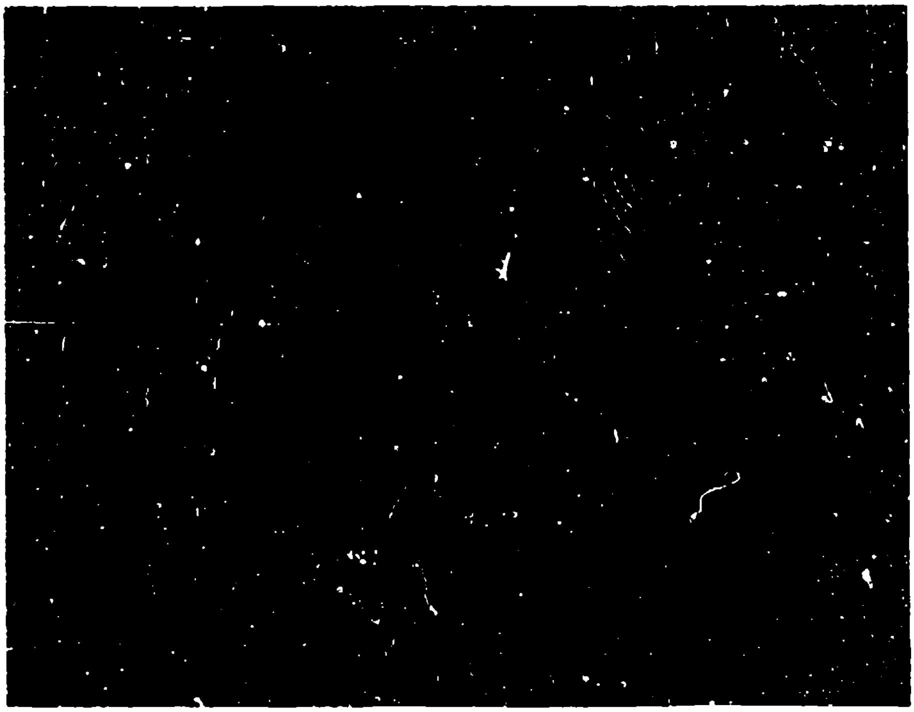


Fig III-29 The new ejection seat survival kit.

Fig III-30 Third human centrifuge at Wright Field, 1948. The human tolerance for normal and emergency space flight trajectories were established with this machine. Bldg. 33.

Fig III-31 Mr. John Frazier wearing the new MB-2 anti-G suit prior to a test on the centrifuge.

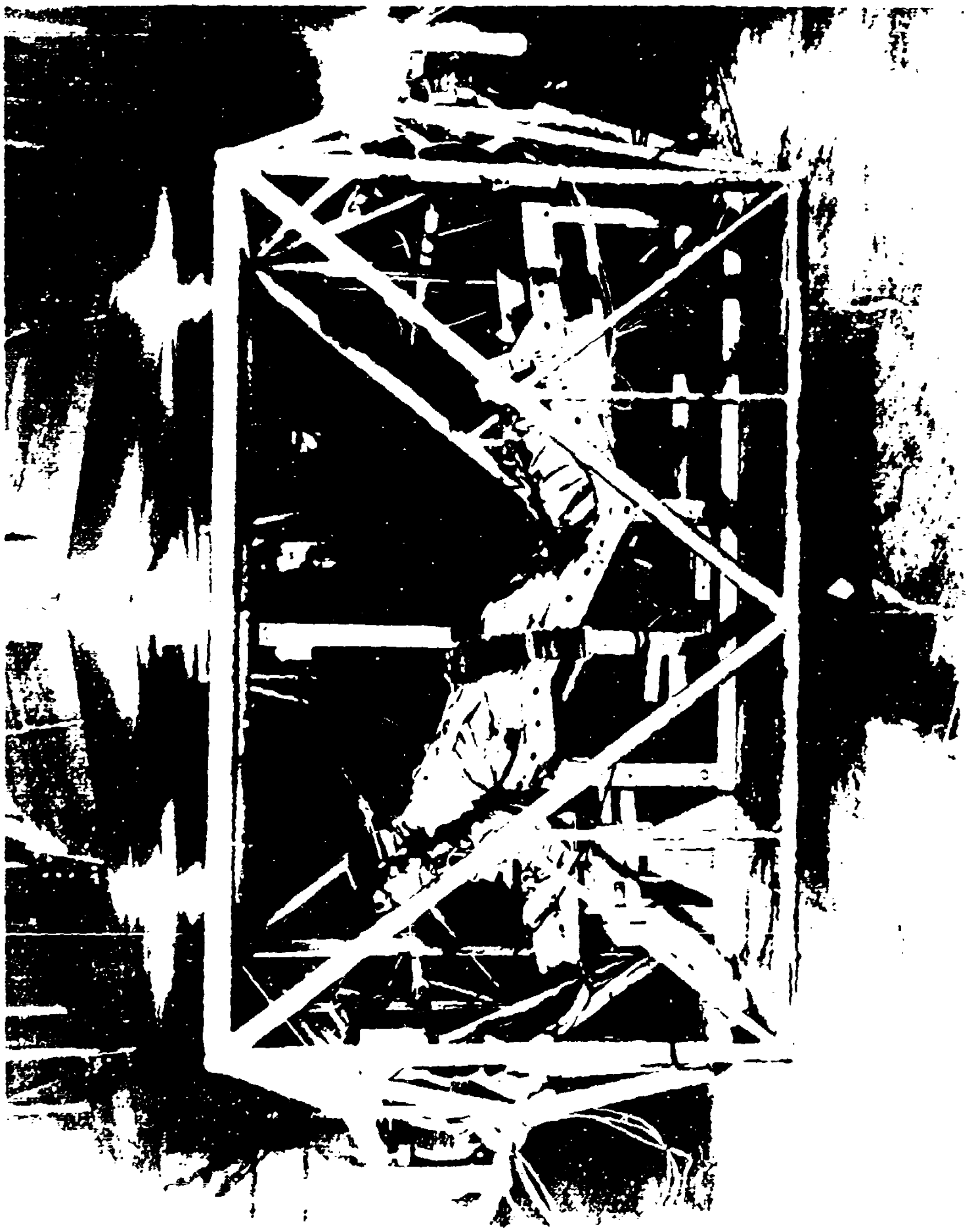


Fig III-32 Mr. Hans Amtmann testing the prone position seat and flight controls on the centrifuge.

Fig III:33 Lt. Dempsey in the modified prone position seat prior to the first human test to 12 G.

Fig III-34 Modified F-80 aircraft equipped with a prone position cockpit. Aircraft was routinely flown to +9G.

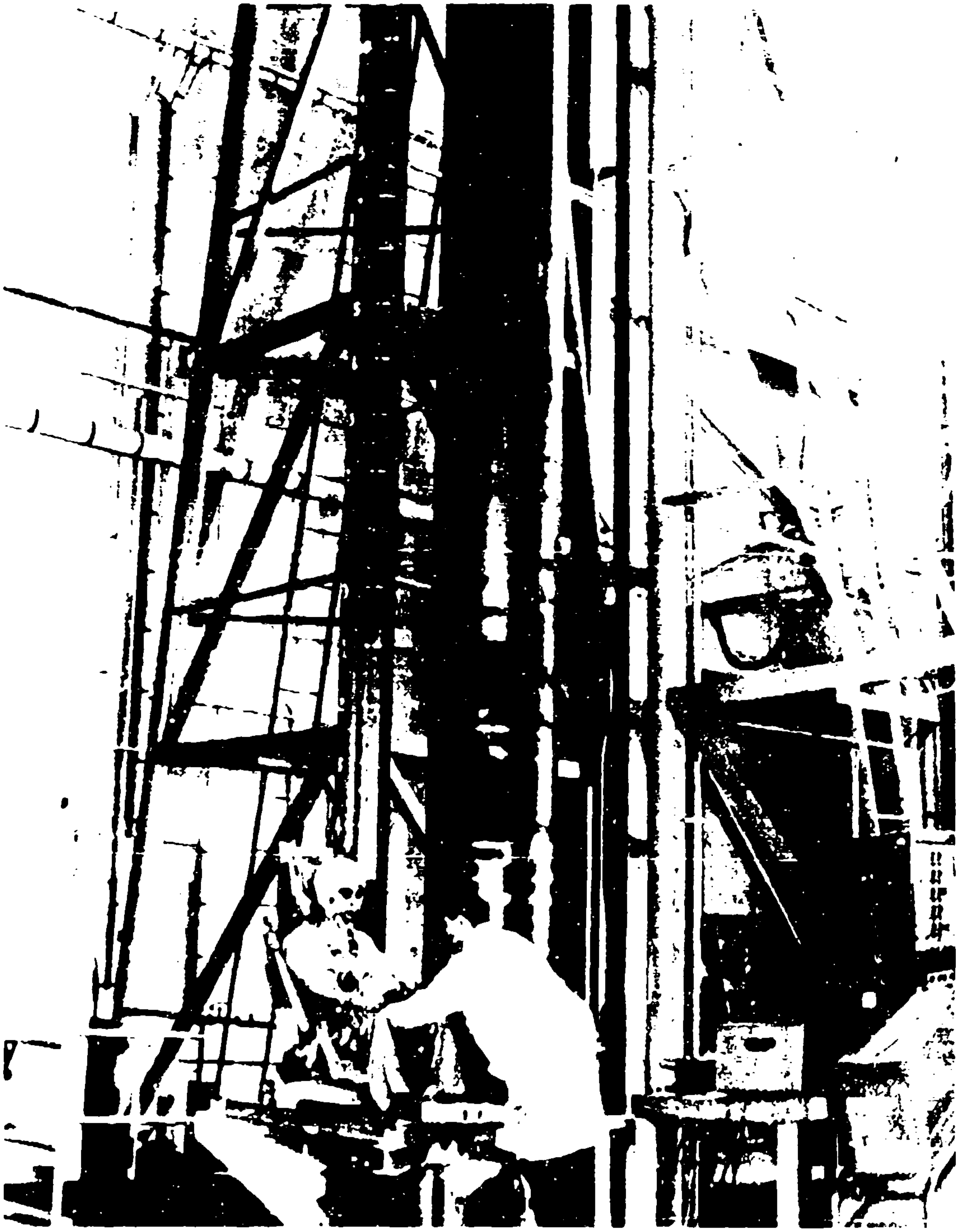


Fig III-35 Vertical accelerator which can simulate the accelerations encountered in low altitude high speed flight.

Fig III-36 *Laboratory test facility for the first crew fatigue study of the nuclear powered aircraft.*

Top Row
Unknown, Unknown, Unknown, Cecil Lazar

Middle Row
Chuck Dempsey, Unknown, Len Eisen, John Duddy, George Ruff, Rufus Hessberg, Vic Thaler

Bottom Row
Charley Meyers, Jim Brinkley

Fig III-37 First aircrew used in the nuclear powered aircraft crew fatigue studies (120 hours)

Len Eisen, Chuck Dempsey, John Duddy, Dick Willis, Unknown, John Simons, Bob Hegenberger, Unknown, Rufus Hessberg, George Ruff, John Roth.

Fig III-38 High altitude flight clothing for jet aircraft, developed and tested by the Clothing Branch.

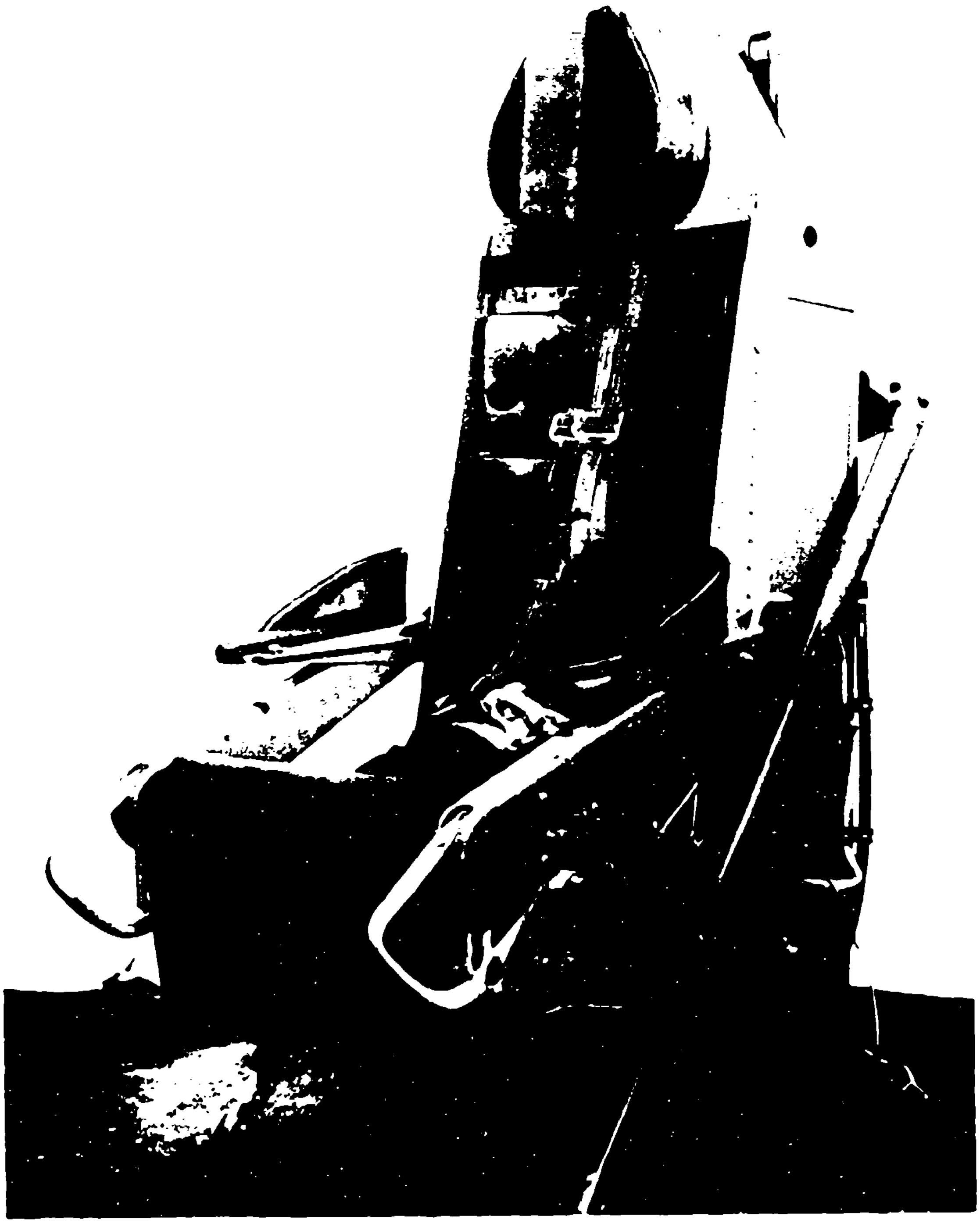


Fig III-39 The first tiltable ejection seat for long range jet flight missions.

Fig. III-40 First contour mapping of the surface of the human body for anthropometric measurements

CHAPTER FOUR

SPACE FLIGHT RESEARCH 1959-1969

ORGANIZATION AND COMMAND

The name of the Aero Medical Laboratory was changed to Aerospace Medical Laboratory on August 3, 1959.

Wright Air Development Center was redesignated Wright Air Development Division on December 15, 1959. The Aerospace Medical Laboratory was concurrently renamed Aerospace Medical Division. It was organized into four components: Biomedical Laboratory, Behavioral Sciences Laboratory, Life Support Systems Laboratory, and Personnel Laboratory (located at Lackland Air Force Base, Texas).

The Biomedical Laboratory directed research in the biomedical, biological, and related physical sciences for application to aerospace systems, to produce maximum effectiveness of both the human and physical components of systems to which biological knowledge may contribute.

The Behavioral Sciences Laboratory directed research in the behavioral sciences to produce maximum effectiveness of the human component in aerospace systems.

The Life Support Systems Laboratory directed research in engineering sciences to develop techniques and principles for the protection, sustenance, and survival of aerospace systems operating personnel.

Personnel Laboratory conducted research and development in support of the operation and qualitative improvement of the Air Force Personnel System. This included the development of concepts and techniques concerned with the functional areas of personnel requirements, procurement, classification, training assignment utilization, proficiency measurement, promotion, retention, separation, and accounting.

Colonel John Stapp was transferred to the Aerospace Medical Center at Brooks Air Force Base, Texas, in August 1960, and at that time Col. Andres Karstens assumed command of the Division.

The Aerospace Medical Division was reassigned from the Directorate of Advanced System Technology, WADD, to the Assistant for Bioastronautics, Hq ARDC, and redesignated the Aerospace Medical Laboratory on November 20, 1960.

On this date, the Laboratory lost responsibility for engineering and development of end items. The operational support development area 580 A: human factors, human engineering application work, systems engineering functions, and personnel subsystems activities were removed from the bioastronautics research mission. They remained the responsibility of the Directorate of Systems Engineering under WADD. The Clothing Branch was transferred into the Systems Engineering organization. Various other smaller functions and their personnel were reassigned to the Systems Engineering mission. The Laboratory was directed to provide bioastronautics technical support to the engineering organizations when requested.

In 1961, Aeronautical Systems Division (ASD) was established at Wright-Patterson in conjunction with the activation of the Air Force Systems Command (AFSC) with headquarters at Andrews Air Force Base, Maryland. This change reflected a growing need to meld the

acquisition, delivery, and support of modern systems, together with their development, into a single management effort. Need for this concept of systems management was spurred on by the quickening pace in technological development. Creation of the Air Force Systems Command consolidated research and development of systems with the follow-on functions of systems procurement and production. Previously these follow-on functions had been carried out by the Air Materiel Command (AMC), which in the reorganization became the Air Force Logistics Command (AFLC). ASD, then, was born from the merger of two organizations at WPAFB, the former Wright Air Development Division and AMC Aeronautical Systems Center.

The Aerospace Medical Laboratory was assigned to the Aeronautical Systems Division on May 8, 1961. The Physical Anthropology Section was transferred from the Biophysics Branch, Biomedical Laboratory, to the Human Engineering Division. Behavioral Sciences Laboratory.

The Aerospace Medical Division, Air Force Systems Command, was established on November 1, 1961. It was formed by combining certain elements which had been assigned to three different major commands of the Air Force: the Alaskan Air Command, the Air Training Command, and the Air Force Systems Command.

The Aerospace Medical Laboratory was assigned to the new Aerospace Medical Division on January 1, 1962. The name was changed to 6570th Aerospace Medical Research Laboratories.

The emblem of the 6570th Aerospace Medical Research Laboratories was approved on December 13, 1963.

Col. Karstens departed the Laboratory on January 16, 1964 and Col. Joseph Quashnock assumed Command of the Laboratory.

The Laboratory went through a major reorganization on November 22, 1965. The Biophysics Laboratory, Physiology Division, Multienvironment Division, and Biotechnology Division were all abolished. The Environmental Medicine Division, Life Support Division and Toxic Hazards Division were established. These three Divisions and the existing Biodynamics and Bionics Division were all placed under the existing Biomedical Laboratory. The Technical Editing Office, and the Library were assigned to the Technical Operations Office. The Biospecialities Branch was abolished and the Nutrition program was transferred to the School of Aerospace Medicine. Project 6301 was transferred to the School of Aerospace Medicine.

Col. Quashnock was transferred to the Aerospace Medical Division on June 13, 1966 and Col. Ray Yerg assumed Command of the Laboratory.

The Training Research Division of the Behavioral Laboratory was transferred to the newly established Air Force Human Resources Laboratory on July 1, 1963.

Col. Ray Yerg was transferred to Hq. USAF on August 1, 1968 and Col. Clyde Kratochvil assumed Command of the Laboratory.

Dr. J. W. Heim, the first civilian employee of the Physiological Research Laboratory, retired in August 1968 after 32 years service. Dr. Heim was hired by Captain Armstrong in June 1936.

The Laboratory was reorganized on September 1, 1968. The Behavioral Sciences Laboratory and the Biomedical Laboratory were abolished. The Biodynamics and Bionics Division, Human Engineering Division, Multienvironment Division, and Toxic Hazard Division were established.

The Laboratory management structure on 30 June 1969 included Biodynamics & Bionics Division, Environmental Medicine Division, Human Engineering Division, Support Services Division, Technical Operations Division, Toxic Hazards Division and Veterinary Medicine Division.

U. S. AIR FORCE AIRCRAFT

B-1, B-47, B-52, B-57, B-58, C-123, C-124, C-135, C-141
F-4, F-15, FB-111, F-16, F-101, F-104, F-105, F-106
T-33, T-37, T-38, T-39, KC-135
Manned Orbiting Laboratory (MOL) X-20 (Dyna-Soar)

NASA SPACECRAFT

Project Mercury, Project Gemini, Project Apollo
X-15 Research Vehicle

CHALLENGING AEROMEDICAL PROBLEMS

- Environmental control standards for space cabins
- Abrupt acceleration for landing of manned space vehicles
- Human performance and mobility in weightless environment
- Human performance in rendezvous of two space vehicles
- Human tolerance to emergency thermal conditions in space
- Nutritional requirements for long term space flight
- Toxicological requirements of space cabins
- Operational validation of space pressure suits
- Human protection requirements for space radiation
- Human tolerance and performance during reentry flight
- Environmental noise standards for rocket engines
- Human tolerance to low altitude buffeting flight
- Training research requirements, simulation and personnel

PIONEERING ACHIEVEMENTS

- Aero medical crew selection program on thirty-two astronaut candidates for NASA, Project Mercury (AMRL, 1959)
- Establishment of Bionics program (Dr. von Gierke, 7231, 1959)
- Extended range aircrew fatigue study using a B-47, established a World record for non-stop jet flight; 39,000 miles in 80 hours (Mr. Dempsey, Capt. Van Wart, 7222, 1959)
- First operational full pressure suit (X-15) (Dr. Vail, 7164, 1959)
- Established Project Mercury reentry tolerance (Captain Clarke, 7222, 1959)
- Anthropological criteria for pressure suit evaluation (Mr. Alexander, 7222, 1959)
- Initiated research on design of remotely controlled devices, manipulators, and robots in anticipation of nuclear aircraft and space maintenance requirements (Mr. Baker, Mr. Crawford, Mr. Kama, Captain Pigg, 7184, 1959)
- Developed frictionless devices based on concepts for air bearing cars, to simulate weightlessness in support of human engineering research related to anticipated space maintenance requirements (Mr. Dzendolet, Mr. Rees, Mr. Kama, Mr. Rievley, Captain Pigg, 7184, 1959)
- Landing impact criteria for B-58 and B-70 crew escape capsules (Captain Headley, Mr. Brinkley, 7222, 1959)
- First Human Engineering Design Criteria Military Standard (Mr. Ring, Mr. Feagans, 7184, 1959)
- Spacecraft landing impact program (Project Mercury)(Mr. Brinkley, Captain Headley, 7222, 1960)

- High altitude emergency escape program. Captain Kittinger set new World record with a 102,400 feet free-fall parachute jump (Capt. Kittinger, Mr. Dempsey, 7222, 1960)
- Passive environmental control system, seven day human experiment (Mr. Keating, 6373, 1960)
- First quantification of the contribution of human performance to missile system test reliability (Mr. Bates, 7184, 1960)

- Space radiation shielding flights using Discoverer XXXII (Mr. Pittman, Mr. Speakman, 6301, 1961)
- Large scale community rocket noise survey of Cape Kennedy (Mr. Cole, 7231, 1961)
- Anthropometric survey of Turkey, Greece, and Italy (Mr. Hertzberg, 7184, 1961)
- Anthropometric survey of Japan and sizing program for Japanese pressure suit (Mr. Alexander, 7184, 1961)
- Vibration tolerance criteria for space flight (Dr. Coermann, 7222, 1961)

- Human ejection test of the B-58 capsule (Captain Clarke, 7222, 1962)
- Space Radiation Guide for designers of manned space vehicles (Mr. McGuire, Mr. Speakman, 7165, 1962)
- Spacecraft and Lunar Excursion Module landing impact program (Project Apollo) (Mr. Brinkley, Major Clarke, Captain Weis, 7222, 1962-1964)
- Life Support Environmental simulator, with four man capability becomes operational (Mr. Metzger, 6373, 1962)
- Nutritional requirements study of astronauts (Miss Finkelstein, 7164, 1962)
- Sponsored a technical symposium on "Remote Handling in Space" (Mr. Baker, Mr. Crawford, Captain Pigg, 7184, 1962)

- Joint services Human Engineering Guide to Equipment Design (Dr. Grether, Dr. Warrick, 7184, 1963)
- First Training research on cross-cultural contact skills for Air Force personnel (Mr. Snyder, 1710, 1963)
- Measurement of the effects of "body slump" during ejection acceleration (Project Gemini) (Mr. Brinkley, Captain Weis, 7231, 1963-1964)
- Thomas Domes toxicology research facility becomes fully operational (Dr. Thomas, 6302, 1964)
- Dynamic space rendezvous simulator program (Dr. Clark, Mr. Frost, 7184, 1964)
- Research program to develop permselective membranes for continuous carbon dioxide control (Mr. Keating, 6373, 1964)

- Initiation of the research program on helmet mounted sights (Mr. Bates, 7184, 1965)
- First multisensor real-time reconnaissance flight tests in conjunction with the Avionics Laboratory (Mr. Bates, Mr. Heckart, 7184, 1965)
- Conduct of Mission Panel #1, Manned Orbiting Laboratory, flight tests aboard JRB-47 aircraft with Dr. Fitts representing the Scientific Advisory Board. This was Dr. Fitts last participation in a Laboratory/Air Force program before his death in 1965 (Mr. Bates, 7184, 1965)
- First toxicology conference on Atmospheric Contamination in Confined Spaces (Dr. Thomas, 6302, 1965)
- First research program on toxicological qualification of Apollo, MOL, SKYLAB cabin materials in the Thomas Domes. This research was a two year program and included 800 materials either singly or in combination (Dr. Back, 6302, 1965)
- The lateral firing gun sight was developed. Firing tests were conducted in a C-47 at Eglin AFB (Captain Simons, Mr. Flexman, 7184, 1965)
- Mobile laboratory measurement of acoustic noises from rocket nozzles (Mr. Cole, 7231, 1965)

- The Dynamic Response Index (DRI), an integrated mathematical measure of physiological response to abrupt acceleration, was developed for the Air Force ejection seat specification (Captain Mohr, Mr. Brinkley, 7231, 1966)
- The Air Force escape capsule specification was modified to include the radical, a mathematical measure of physiological response to multivector abrupt accelerations. It was first used in the development of the F-111 capsule (Captain Mohr, Mr. Brinkley, 7231, 1966)
- Established the physiological limitations for the development of the HC-130H aerial retrieval system and provided the medical support for human testing of the system (Captain Mohr, 7231, 1966)
- Titan II propellant toxicology research program (Dr. Thomas, 6302, 1967)
- Development of first Helmet Mounted Sight (Mr. Bates, Mr. McKechnie, 7184, 1967)
- Development of the first successful constant volume joints for full-pressure suits (Mr. Bowen, 7164, 1967)
- F-111 crew escape module landing impact program (Captain Mohr, Mr. Brinkley, 7231, 1967)
- A new anthropometric survey of rated male officers was conducted. It included 3,969 men at nineteen different Air Force bases. (Mr. Clauser, 7184, 1967)
- Development of the magnetic pressure sealing closure for pressure suits (Mr. Rosenbaum, 7164, 1967)
- Vibration exposure, performance, and comfort standards were adopted as national and international standards (Dr. von Gierke, 7231, 1967)
- Anthropometric survey of 1900 women in the Air Force (The findings furnished 137 dimensions for the design of clothing and personal equipment for women.) (Mr. Clauser, 7184, 1968)
- Joint AF/NASA study on the radiative-convective heat losses in Gemini and Apollo pressure suits (Mr. Hall, 7164, 1968)
- Study of human tolerance and safe exposure criteria for intense transient heat pulses such as would be encountered in rapid reentry from space (Major Veghte, Captain Callin, 7164, 1968)
- Three Bionics Symposia with international participation were held at WPAFB and one symposium under AGARD auspices was held in Brussels, Belgium (Dr. von Gierke, Dr. Oestreicher, Colonel Steele, 7231, 1960-1968)
- First human test on the Dynamic Environmental Simulator (DES) was conducted on December 19, 1969. Dr. Michael McCally made four runs (Dr. McCally, 7222, 1969)
- Development of first Helmet Mounted Display (Captain Brindle, Mr. Furness, 7184, 1969)
- Development of the partial pressure suit glove (Mr. Rosenbaum, 7164, 1969)
- Development of the Human Engineering System Simulator for multioperator studies of command and control (HESS) (Dr. Topmiller, 7184, 1969)
- First flight test of the Helmet Mounted Sight for air-to-air combat applications in conjunction with the U. S. Navy (Captain Kocian, Mr. Furness, 7184, 1969)

PROJECT NUMBERS		TITLES
6.1	7163	Biomechanisms and Metabolism
	7183	Man-Machine Interaction
	7220	Biophysics Research
	7232	Logical Structure and Nervous System
	7907	Human Learning and Motivation
6.2		Training Research
	6114	Simulation Techniques
	6301	Personal Protection
	6302	Toxicology

6373	Life Support Equipment
7164	Protective Technology
7165	Radiation
7184	Human Engineering
7222	Combined Stress
7231	Biomechanics
7233	Biological Systems

FACILITIES

Acceptance of Vivarium Bldg 838 (1965)

Vertical Deceleration Tower	Bldg 23
Vertical Accelerator	Bldg 23
Heat Pulse Thermal Facility	Bldg 29
Fourth Human Centrifuge (DES)	Bldg 33
Instrumentation Laboratory	Bldg 33
Thomas Domes	Bldg 79
Biochemistry Laboratory	Bldg 79
Flower Hot House	Bldg 79
Fish tank	Bldg 79
Lunar Landing Facility	Bldg 156
Photogrammetry Laboratory	Bldg 196
Anthropology Strength Laboratory	Bldg 196
Human Engineering Computer Facility (HESS)	Bldg 248
Acoustic Chambers	Bldg 441
Electronics Laboratory	Bldg 441
Speech Recognition Laboratory	Bldg 441
Noise Survey Computers	Bldg 441
Helmet Mounted Sight Test Laboratory	Bldg 682
Image Metric Laboratory	Bldg 682
Six Mode	Bldg 824
Vertical Deceleration Tower	Bldg 824
Life Support System Evaluator	Bldg 824
Survival Equipment Test Facility	Bldg 824
Vertical Accelerator	Bldg 824
Subsonic Noise Pressure Chamber	Bldg 824
IMPMODE	Bldg 824

Flight Test Aircraft

KC-135	Human Engineering Division
JKC-135	Human Engineering Division/Avionics Laboratory
JWB-50	Human Engineering Division
JRB-47	Human Engineering Division
JC-131	Human Engineering Division

THE LABORATORY PROGRAMS

OVERVIEW

The Laboratory had been in existence only twenty-four years when the challenge of manned space flight dominated the conversation, research, and funding. The Air Force had several programs in planning, research and development while the NASA was developing their own

program on a national scale. The NASA activity did not have adequate Biotechnology capability, and they called on the resources of the Laboratory to provide the necessary technical support. In addition, the Air Force manned aircraft programs were highly sophisticated with flight missions which reached the outer limits of human capability. Two aircraft, the B-1 and the FB-111, were to be equipped with the new multiplace emergency crew escape module system. The human engineering problems were at the threshold of technology due to air vehicle performance and the explosive growth of avionics. This was truly the beginning of space flight research in all areas of the Laboratory. It was an exciting time.

This period also saw the escalation of warfare in Southeast Asia and a renewed interest in air-to-air and air-to-ground combat effectiveness. In 1966, many of the Laboratory programs were focused on weapon system support activities and classified combat programs. The majority of the work was devoted to rapid corrections of technical or combat problems based on the weekly briefings and technical assignments given to the Laboratory through the ASD Limited War Office. This office was the focal point for all engineering support and funding assigned to Wright Field. The Laboratory also provided biotechnology support to other agencies who had limited war assignments requiring physiological or psychological data. The Human Engineering Division activities were primarily in support of the urgent need for reliable near real time reconnaissance under poor weather conditions in a heavy jungle environment and the accurate delivery of aerial ordnance in close proximity to friendly forces. The Biodynamics and Bionics Division was involved in the communications problems encountered on combat missions and correction of the F-4 ejection seat spinal injury problems.

SELECTED PROGRAMS

At the request of NASA, the Laboratory conducted, over a seven week period, a special Crew Selection Program and astronaut training for all thirty-two candidates in Project Mercury. The candidates were processed through a series of tests designed to determine individual ability to withstand physiological and psychological stress. This test program revealed a few subjects were not suitable for the project. All candidates recommended by the Laboratory Crew Selection Program were also chosen by NASA. Each astronaut candidate underwent an altitude chamber test, acceleration test, high temperature test, and a performance check in the X-15 simulator. They were also flown in weightlessness maneuvers in the C-131B aircraft. Full pressure suits were used in all tests for familiarization and training of the astronauts (AMRL, 1959)

Using a B-47 aircraft with a three man crew, extended flight experiments on aircrew habitability and crew fatigue were conducted. Special equipment was designed and installed in the rear cockpit for this flight: the first tiltable ejection seat, a pulsating seat cushion, an inflatable back cushion, and a massaging G suit. The pilot in this special cockpit flew the aircraft and never got out of the seat for the entire flight. He was equipped with an electronic recording device which continuously transmitted his physiological status to the ground receiving equipment for analysis. This program established a new world's record for nonstop jet flight, 80 hours 36 minutes for a distance of 39,200 miles (Mr. Dempsey, Captain Van Wart, 7222, 1959)

The first landing impact tests of manned space vehicles using human subjects were made at the Inclined Test Facility at Wright Field. One hundred twenty drops were conducted using the Project Mercury simulator. Forty-one were made with the volunteer subjects in the rigid Mercury couch. The test program explored impact velocities up to 30 feet/second stopping in 5 inches (Captain Headley, Mr. Brinkley, 7222, 1959-1960)

Project Hermes, a closed circuit, integrated life support system capable of supporting one man for 7 days, was developed. An experiment using one human subject was conducted for 168 hours. This test using a passive atmosphere-chemical reaction principle involved potassium superoxide and proved the feasibility of using solid chemicals to maintain a life-supporting environment. This was a fundamental and dramatic demonstration of an alternate approach to environmental control (Mr. Keating, 6373, 1960)

Experiments to establish mass discrimination capabilities of maintenance personnel under simulated weightlessness conditions were conducted using frictionless devices (air bearings) and aircraft flying keplerian trajectories (Mr. Rees, Ms. Copeland, 7184, 1960)

The Laboratory initiated a high-altitude emergency escape program in 1955. This five year program was designed to gather biotechnology data on escape at altitudes in excess of 100,000

feet. Specific information about environmental forces at the time of escape, pressure suit functioning during escape, parachute drogue deployment, free fall stability, free-fall velocity, physiological response, such as shock or loss of consciousness, oxygen flow, and parachute loads at main canopy opening were desired. These data were gathered through instrumentation carried in the survival kit. Since an aircraft could not reach such altitudes, the plastic balloon open gondola was used. In the period from 1956 until 1958 the Laboratory had flown many such balloons and made many dummy drops with attached instrumentation packages. The length of the development program prevented the use of four different qualified parachutists who were transferred to other assignments. In 1958, a test parachutist, Captain Joe Kittinger, became available to the program. During November and December 1959, two high altitude stabilized free-fall experiments were made using an open gondola from 74,800 to 76,400 feet. The second jump was satisfactory. Free-fall stability of the man through the use of a specially designed drogue parachute was achieved. Mr. Francis Beaupre designed the parachute system. On the next test flight on August 16, 1960, Captain Joe Kittinger established a new world's altitude record (102,400 feet) for free-fall parachute jump. A new manned balloon flight record was also established. All instrumentation data was recovered and analyzed. This data was provided to NASA for use in their manned space flight program (Captain Kittinger, Mr. Dempsey, 7222, 1960)

The significant advances in aircraft flight speeds and the acceleration forces encountered during emergency escape required the development of mathematical analogs to depict the human response to impact, predict potential injury, and serve as an objective basis for protection system design and evaluation. This combined contract and in-house efforts studied the ejection seat acceleration environments and operational injury rates to verify the mathematical analog used to assess spinal injury. The spinal model was modified to account for operational experience. This model was incorporated into MIL-S-9479, the specification for upward ejection seats, and MIL-C-25969B, the specification for enclosed escape systems. The Dynamic Response Index is now used throughout the escape system industry. It forms the basis for an Air Standard on acceleration limits used by the United Kingdom, Canada, Australia and New Zealand. (Mr. Brinkley, 7222, 7231, 1960-1975)

The 50 foot vertical deceleration tower became operational and was manrated. This was an indoor test facility for studying the effects of abrupt acceleration on animal and human subjects. It used a fully programmable water piston decelerator. The drop carriage had an adjustable device to accept different types of seat support systems or animal supporting devices (Captain Clarke, 7231, 1961)

The Bionics program developed a new mathematical technique for the analysis of human controller dynamics. A self-adapting controller program in remote systems was initiated. The term "bionics" was coined by Dr. Jack Steele of the Laboratory. (Dr. Oestreicher, 7231, 1961)

Equipment and facilities were developed to conduct realistic research on training of operator and maintenance personnel. The major facilities were an AN/APQ T-1 Radar Trainer, a modified AN/ASB-4 Bomb-Nav system, and a bench test set for the MA-2 Bomb-Nav system. Four studies were made that outlined systematic procedures for planning the needed personnel requirements and training aspects for weapon systems. In cooperation with the Air Training Command, a course on the fundamentals of electronics was automated and comparisons were made between conventional training and two techniques of automation (Mr. McNulty, 1710, 1961)

The second experimental model pressure suit from the International Latex Corp. showed a vast improvement over the previous model. The garment had a number of interesting features that could be considered for future use and product improvement. The bellows-type joints were of interest because they were applied not only to the legs and arms, but also to the hip, shoulder, and neck areas. The garment created considerable interest among those concerned with the capability of man to do useful work in orbit around the Earth and Moon (Mr. Bowen, 7164, 1961)

At the request of the Dyna-Soar Engineering Office, the Laboratory engaged in an investigation of five pressure suits. Data on ventilation, flow, and leak rates were compiled. Comparative data, such as suit weights and subjective comments on mobility and comfort were obtained. Critical anthropometric measurements were taken on each suit at 3.5 and 5 psi inflation pressures (Mr. Bowen, 7164, 1961)

A major facility, the Life Support Systems Evaluator, was designed by Laboratory project engineers. This facility, a four-man environmental test chamber allowed study of the technical feasibility of theories and principles of life support systems and system components. Two unique features that made the facility outstanding were a controlled and calibrated atmosphere leak, and a double wall construction permitting an area of lesser pressure around the interior environment, thus assuring that the atmosphere being researched was not contaminated by inboard leakage (Mr. Roundy, 6373, 1962)

Fit tests of the A/P 22S-2 Full-Pressure Assemblies were conducted at Tyndall AFB. Preliminary results indicated the sizing program was highly successful. Anthropology Section's 8-size, height-weight sizing program was used as the sizing specification for the pressure suit. Advantages afforded by the height-weight system were comfort of the assembly, accuracy of determining procurement tariffs, minimizing custom-tailoring, ease of issuing the correct indicated size (only pilot's height and weight were necessary,) and coverage of the body size distribution of the USAF pilot population (Mr. Alexander, 7184, 1962)

In response to an urgent request from NASA, a series of studies were expedited exploring man's response to the impact forces associated with ground landing of the Apollo command module. One hundred human tests were conducted. Results were immediately applied to design of the Apollo vehicle (Major Clarke, Captain Weis, Mr. Brinkley, 7231, 1962)

The development of an electrical analog of the ear was completed. Theoretical background relative to speech recognition was formulated and intelligible speech compression to a bandwidth of 20Hz was demonstrated (Dr. Mundie, 7231, 1962)

Over 50 biothermal research experiments were performed in the Environmental Test Facility. Cardiovascular effects of steady state-heat stress(100-160 F) were studied with catheterization techniques and correlated with biothermal responses. Human circulatory and temperature adjustments to extreme heat pulse (70 to 400 F at 180 F/min) were also measured. Using the new precision weighing system, the insensible weight losses of clothed resting subjects in comfort temperatures were measured and importance of ambient temperature control in human water balance during extended aerospace missions demonstrated. Experiments in extreme heat (100-160 F) to determine air flow temperature requirements for various prototype full pressure suits and range of unimpaired physiologic performance were completed. In cooperation with NASA, several Gemini prototype suit evaluations were included. New predictive data useful in cold water immersion exposures were developed. These included both wet and dry clothing concepts and applied to both water or life raft exposures (Mr. Hall, 7164, 1962)

The Medical Electronics Section developed a telemetering technique for use in both human and animal studies. This system recorded ECG, impedance respiration, and body temperature. This equipment can be used for telemetering physiological and associated data from space vehicles in extended flight missions (Dr. Marko, 7231, 1962)

Data from a program on radiation shielding for personal protection were assembled into a complete set of computer codes that described the geophysical radiation environment, mission trajectory of a manned space vehicle to the moon, the attenuation of vehicles having a 6 gram/sq centimeter structure, and the interactions of radiation with known materials. In addition, the biomedical tolerance of man to space radiation was obtained for use with these data. The program was augmented by a research contract that integrated this complete spectrum of data into a computer trade-off study of radiation protection concepts for shielding of astronauts. The computer programming employed subroutines representing discrete blocks of data that could be easily withdrawn and replaced; for example, with variations in mission trajectory, vehicle construction details, or new environmental data (Mr. McGuire, Mr. Speakman, 7165, 1962)

A summary report of the results of a joint FAA-NASA-USAF study of community reactions to sonic booms was completed and a contract for continuation of the work for another two years was negotiated with the contractor. This work was designed to predict the type and extent of community responses to be expected from regular operations of supersonic transport aircraft. Information gained from studies of reactions to current military supersonic operations was expected to influence strongly the design and operation of future US supersonic transport aircraft (Mr. Cole, 7231, 1963)

Walking behavior during lunar and other low gravity conditions was analyzed with time and displacement measures of the lower limbs. Two subjects were photographed as they walked over a calibrated distance in an aircraft flying low gravity maneuvers. The inadequacy of proper body control in the region below 0.2 G tended to substantiate previous estimates of the lower gravity limit for walking (Captain Simons, Major Brown, 7184, 1963)

The Training Research Division conducted an intensive study of the training requirements for USAF operations in limited warfare. The most important finding in this study was that USAF personnel were inadequately prepared for contact and work with people in other cultures. A major research program to develop techniques for training cross-cultured interaction skills was initiated (Mr. Snyder, 1710, 1963)

A jointly sponsored AF and NASA program was initiated to determine the energy, water, and protein requirements of man during the prolonged wearing of pressure suits and the superimposed stresses of isolation, reduced atmosphere and heat. There were four experiments which lasted 42 days each. In each experiment, four subjects were confined in the Life Support Systems Evaluator. During the first 21 days of the experiment, each subject subsisted on a one day cycle of fresh, frozen and heat processed foods. The last 21 days each subject was given a liquid nutrient refined diet providing 2,700 kilocalories per day (Mr.Metzger, 6373, 1964)

A dynamic visual space simulator was installed in the Laboratory. The simulator has a cathode ray tube to display the visual environment that an astronaut might observe through a porthole of a space vehicle with regard to the star background, earth horizon, and a target vehicle. A subject sitting in a simulated vehicle was able to interact with the simulated environment by controlling his vehicle in terms of 6 degrees of motion and 6 degrees of attitude. The simulation was in real-time and the visual dynamics simulate those of operational spacecraft (Dr. Clark, Mr. Frost, 7184, 1964)

The F-111 Crew Escape Module was a major advance in the design of high speed, multiplace aircraft. This new developmental program required a detailed analysis of the acceleration environments generated during the ejection, aerodynamic deceleration and landing impact phases of the crew module escape sequence. The analytical techniques used to evaluate the environments employed the dynamic response analysis technique and the new acceleration radical as a developmental tool. Consultation was also provided on the design or other crew module components such as the restraint harness, the powered inertia reel, and the seat cushion. (Captain Mohr, 7231, 1964)

Working with the Air Defense Command, self-study techniques for aircrew refresher training were developed. The training consisted of three major items. First, there was a comprehensive series of multiple choice questions covering the subject matter with each question bearing reference to the page and paragraph of the manual. Second, there was a punch board where the students could determine immediately whether their answer to each question was correct or incorrect. Third, there was the manual to which students referred for information when they chose an incorrect answer to a question (Dr. Eckstrand, 1710, 1965)

Emergency escape from the F-4 in South East Asia produced an abnormally high spinal injury rate of 50%. A research program was initiated to measure the pilot's spinal misalignment with regard to the Martin-Baker seat ejection thrust vector. With this information and the application of Dynamic Response Index (DRI) technique, changes in the thrust of the ejection catapult were recommended. This action led to a reduction of the spinal injury rate to approximately 12%. (Major Mohr, 7231, 1966)

In the area of toxicology, 90 day continuous inhalation exposures to trace contaminants were started on N2O4, hydrazine, decaborane and UDMH using monkeys, rats, and mice. The toxicity of pyridoxamine and 1-arginine were determined with possible use for therapy of hydrazine intoxication in mind. Six newly synthesized fluorinated benzene polymers were tested for acute toxicity parameters. Two of them, pentafluorophenylhydrazine and pentafluorophenol, possessed an appreciable toxicity having LD50's of 160 and 150mg/kg, respectively. Thirty new propellants and chemical intermediates were screened for toxicological and industrial medicine information. This work helped identify hazardous operations during synthesis, analysis, purification, testing, and firing phases of new liquid and solid propellants (Dr. Back, 6302, 1966)

The Laboratory participated in the development and demonstration of the HC-130H ground-to-air retrieval system. This work included medical consultation on system design, subject selection, medical monitoring and consultation on the test results. After approval of the test protocol, a series of reel-in-reel-out tests, using human subjects were conducted with the HC-130H aircraft. The successful demonstration of the ground-to-air personnel retrieval system was completed when six volunteer subjects were picked up. The tests with humans were accomplished after a series of qualification tests with anthropomorphic dummies. (Major Mohr, 7231, 1966)

Subsequent to the escalation of hostilities in South East Asia, the Laboratory human performance exploratory and advanced development programs in the area of reconnaissance/strike were reoriented from strategic emphasis to tactical. The human performance problems associated with multisensor hunter-killer concepts as employed in a limited war environment were investigated at length within the laboratory and by use of airborne flight test programs. The studies focused on target acquisition using a wide variety of sensors including unaided vision, infrared, low light level television, light amplification devices (such as sniper scopes), laser line scanner and side looking radar (Dr. Self, Mr. Porterfield, Mr. Bates, 7184, 665A, 1966)

A five year study of animals exposed to multiple acute doses of rocket motor exhaust products containing beryllium was initiated. This work in the area of propellant toxicology was particularly significant to the Air Force because it dealt with the characterization of environmental pollution from storable intercontinental ballistic missiles and other large boosters (Dr. Back, 6302, 1967)

A JWB-50D aircraft was acquired by the ASD Test Wing in early 1966 to support human factors test requirements in support of the Program 665A Tactical Near Real Time Reconnaissance (TAC NRT Recce). The aircraft was selected as a flight test platform because the nose observation window and the side scanner windows were conducive to the accomplishment of unaided visual human performance experiments. The complement of recce equipment included a AN/APQ-86 Side-Looking Radar (SLR) with Moving Target Indication, a Reconofax VI downward-looking Infra Red set, a modified K-46 Aerial Strip Camera, two K-17 Aerial Frame Cameras, a CA-112 Aerial Frame Camera, and an experimental subject scoring system. The purpose of this test program was to gather in-flight data on human performance in the airborne detection and recognition of tactical targets with unaided vision and with Infrared and Radar displays and to collect IR and SLR imagery of tactical targets in a simulated South East Asia (SEA) environment. In order to better simulate the SEA vegetative environment and with appropriate targets the aircraft was deployed for the month of July, 1967 to Howard AFB, Panama Canal Zone, and operated with gratifying success. This aircraft was the last JWB-50 to fly for an Air Force unit and was retired to the Air Force Museum upon completion of the test program. The project pilot, Major Ernest P. Hanavan Jr., was formerly assigned to the Human Engineering Division (Mr. Bates, Mr. Heckart, Mr. Porterfield, 7184, 665A, 1967)

Using a special biothermal test facility, pioneering research information was obtained concerning human physiologic response to the hazards of high intensity aerospace thermal environments which may occur in supersonic planes and space flight and during emergencies in such environments. Temperatures ranged from 70 F to 450 F (21 C to 121 C) with special emphasis on the range of 200 F to 400 F. A critical need to precisely determine safe human tolerance to these extreme heat stresses existed since at these high temperatures time exposure differences of 60-120 seconds could represent a difference between more discomfort and painful, disabling burns. Peak exposures of 406 F for 3 minutes for Major Veghte, [illegible] 92 F for 2 minutes for Captain Callin were recorded on September 10, 1968. (Major Veghte, Captain Callin, 7164, 1968)

Considerable progress was achieved in the speech-sound recognition program. Working with an electronic model of the inner ear, the scientists developed a word recognition system for simulation by a computer. Accuracies of 95-99% in word recognition from a 15 word vocabulary were achieved. (Dr. Mundie, 7233, 1969)

Alternative designs for fasteners proposed for space systems applications were evaluated using the Air Force Propulsion Laboratory's six-degree-of-freedom device to simulate zero gravity effects. (Mr. Martin, Mr. Crawford, Mr. Kama, 7184, 1969)

The Dynamic Escape Simulator (DES) was completed in early 1969. Engineering checkout tests were conducted and preliminary operation of the simulator continued throughout the remainder of the year. On December 19, 1969, Dr. Michael McCally made the first human tests on the

DES. There were four runs in this series. This completed the manrating of the new centrifuge. (Dr. McCally, 7222, 1969)

The Human Engineering Division initiated the development of a computer-centered, real-time simulator to study man-machine system problems. This Human Engineering System Simulator (HESS) was an IBM 360-40 computer with 256K storage capacity, later expanded to 512K memory. It was used to conduct the multioperator command and control simulation in support of the AWACS aircraft. (Dr. Topmiller, 7184, 1969)

AWARDS

1959	Major Elizabeth Guild	Air Medal
1960	Mr. John Cole	Arthur S. Fleming Award
1960	Mr. Don Rosenbaum	ASD Outstanding Inventor
1960	Captain Joe Kittinger	Aerospace Primus Award
1961	Mr. John Cole	AEF R&D Award
1961	Dr. Henning von Gierke	AEF R&D Award
1963	Dr. Henning von Gierke	DOD Distinguished Civilian Service Award
1963	Major Jim Veghte	AF Commendation Medal
1964	Dr. Walter Grether	Franklin V. Taylor Award
1965	Major Don Gisler	AF Commendation Medal
1965	Major John Simons	AF Commendation Medal
1965	Major John Simons	Legion of Merit
1966	Mr. Thomas Furness	Colonel Knight Award
1966	Dr. Julien Christensen	AFA Citation of Honor
1966	Dr. Henning von Gierke	Eric Liljencrantz Award
1966	Dr. Julien Christensen	Exceptional Civilian Service
1966	Dr. Walter Grether	Exceptional Civilian Service
1966	A F A M R L	AF Outstanding Unit Award
1967	Dr. Anton Thomas	Exceptional Civilian Service
1967	Captain George Mohr	AFSC Surgeon of the Year
1967	Mrs. Molly Pinkerton	Meritorious Civilian Service
1967	Mr. Jim Brinkley	NSPE Engineer of the Year
1968	Mr. Jim Brinkley	Meritorious Civilian Service
1968	Dr. Jim Van Stee	NASA Science & Eng. Award
1968	Captain George Mohr	Gen. Hoyt Vandenberg Trophy
1968	Captain George Mohr	USAF R&D Award
1969	Major John Simons	Legion of Merit (Oak Leaf)
1969	Major Jim Veghte	Aerospace Primus Award
1969	Captain Grant Callin	Aerospace Primus Award

Fig IV-1 *Scotty Crossfield wearing the first X-15 full pressure suit, (XMC-2-DC) with a modified MA-1 helmet.*

Fig IV-2 C-131B aircraft modified into a weightlessness laboratory for human engineering research.

Fig IV-3   Mercury astronauts after weightlessness flight.

Fig IV-4   Mercury astronaut John Glenn in weightlessness flight training.

Fig. IV-[illegible] Human engineering experiments on maintenance of rocket engine during weightlessness flight

Fig IV-6 Mercury astronuat in the heat chamber

Fig IV-7 Mercury astronaut in the Physiology Laboratory.

Fig IV-8   Mercury astronaut in the intense noise chamber.

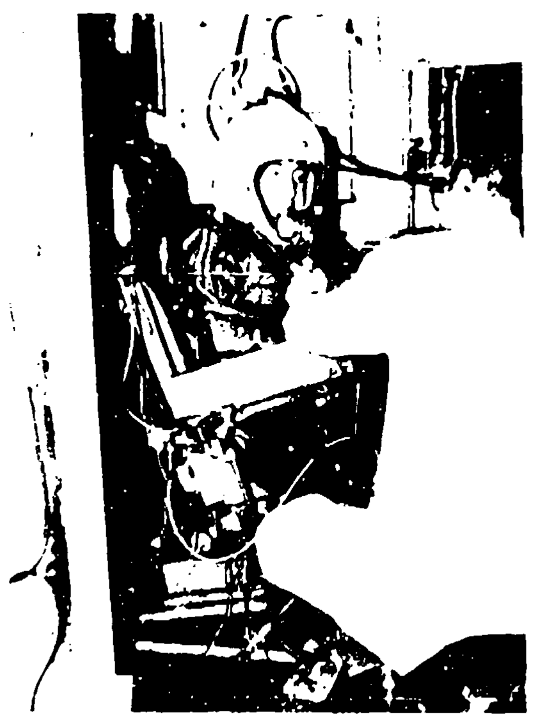


Fig IV-9   Mercury astronaut in the altitude chamber.

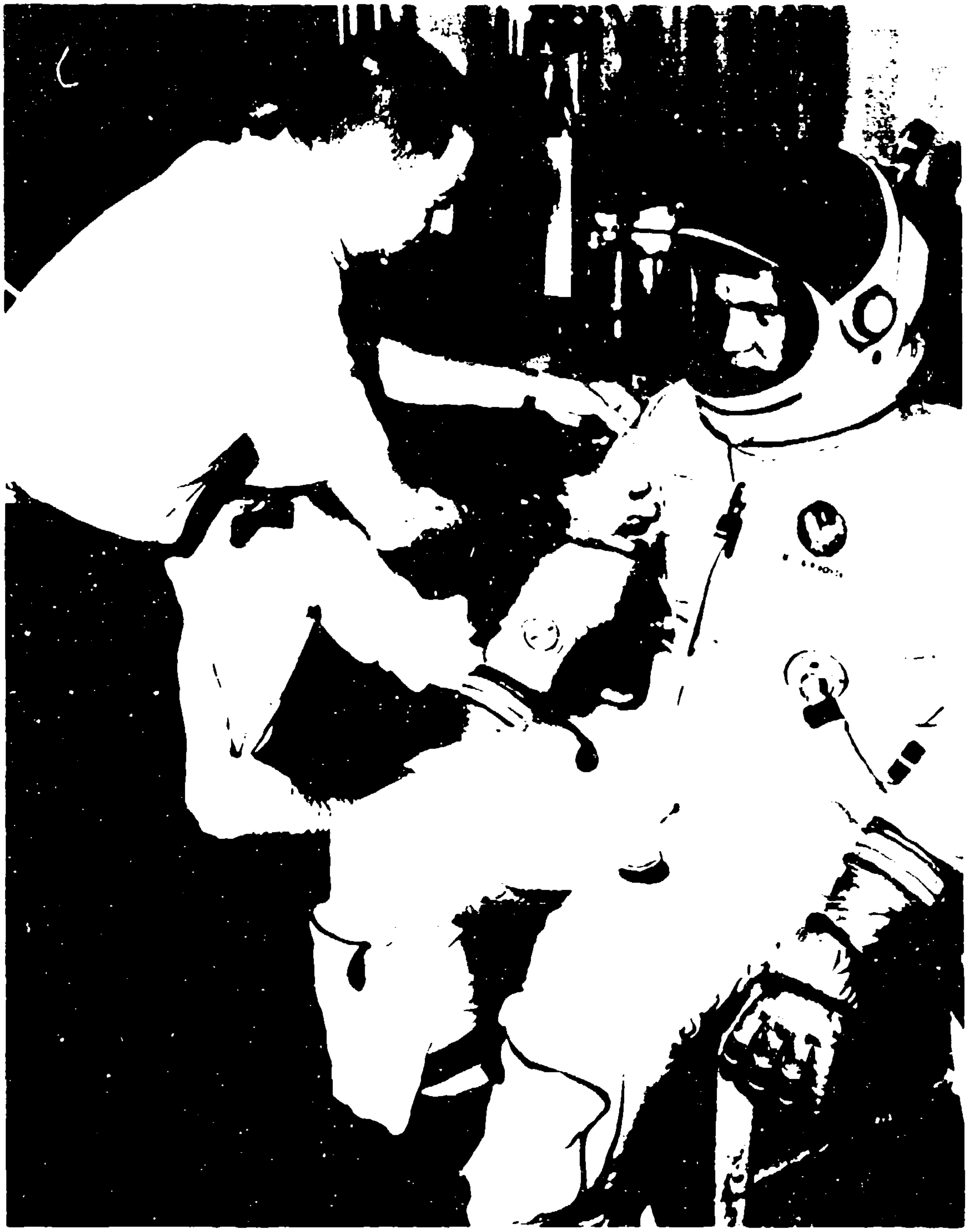


Fig IV-10 Mr. Alexander taking anthropometric measurement on an inflated pressure suit for establishment of cockpit dimensions.

Fig IV-11 Inclined test facility at Wright Field. It was used in the first landing impact studies of the Mercury spacecraft.

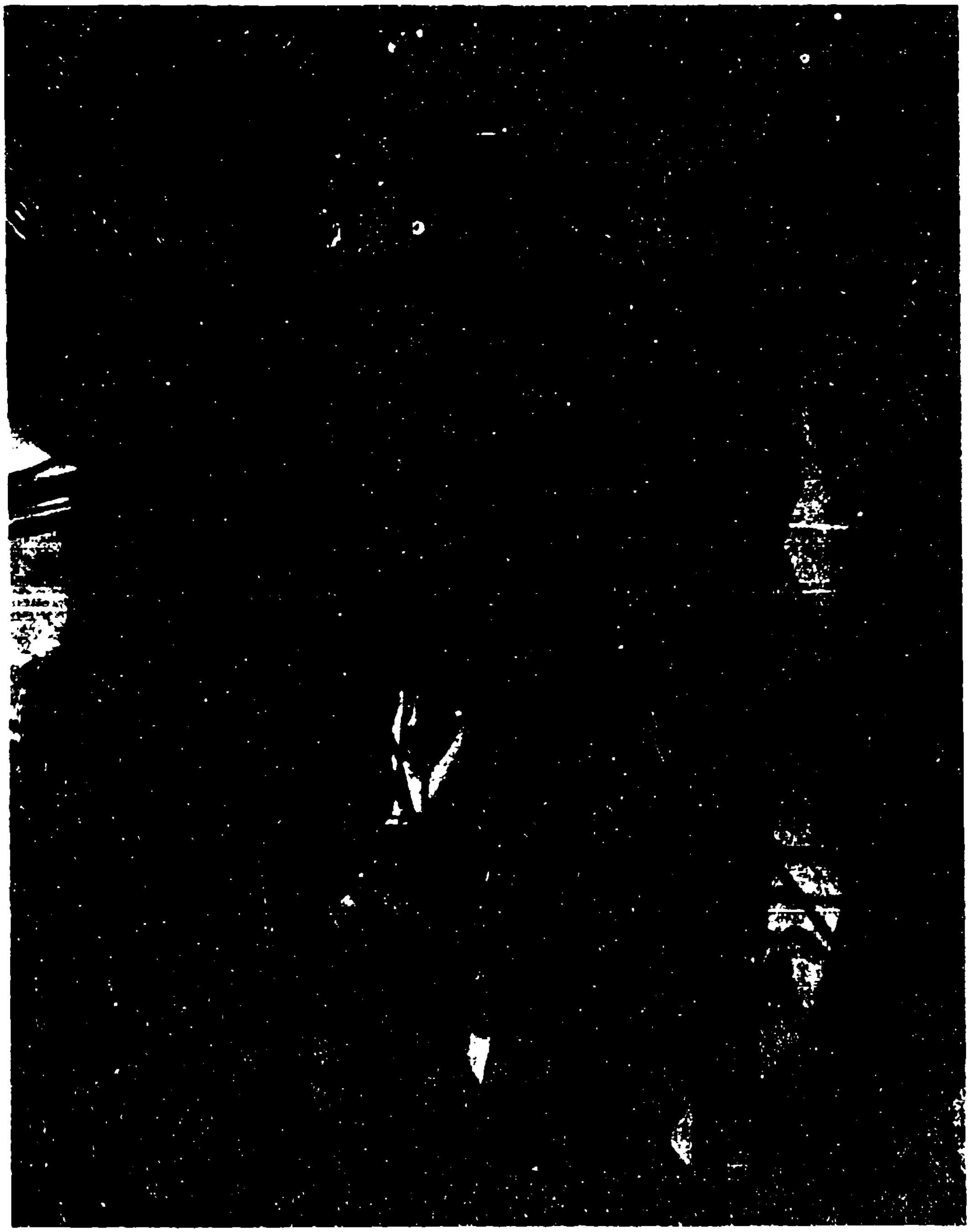


Fig IV-12 Human subject in the Mercury couch prior to the first landing impact experiment of the Mercury spacecraft.

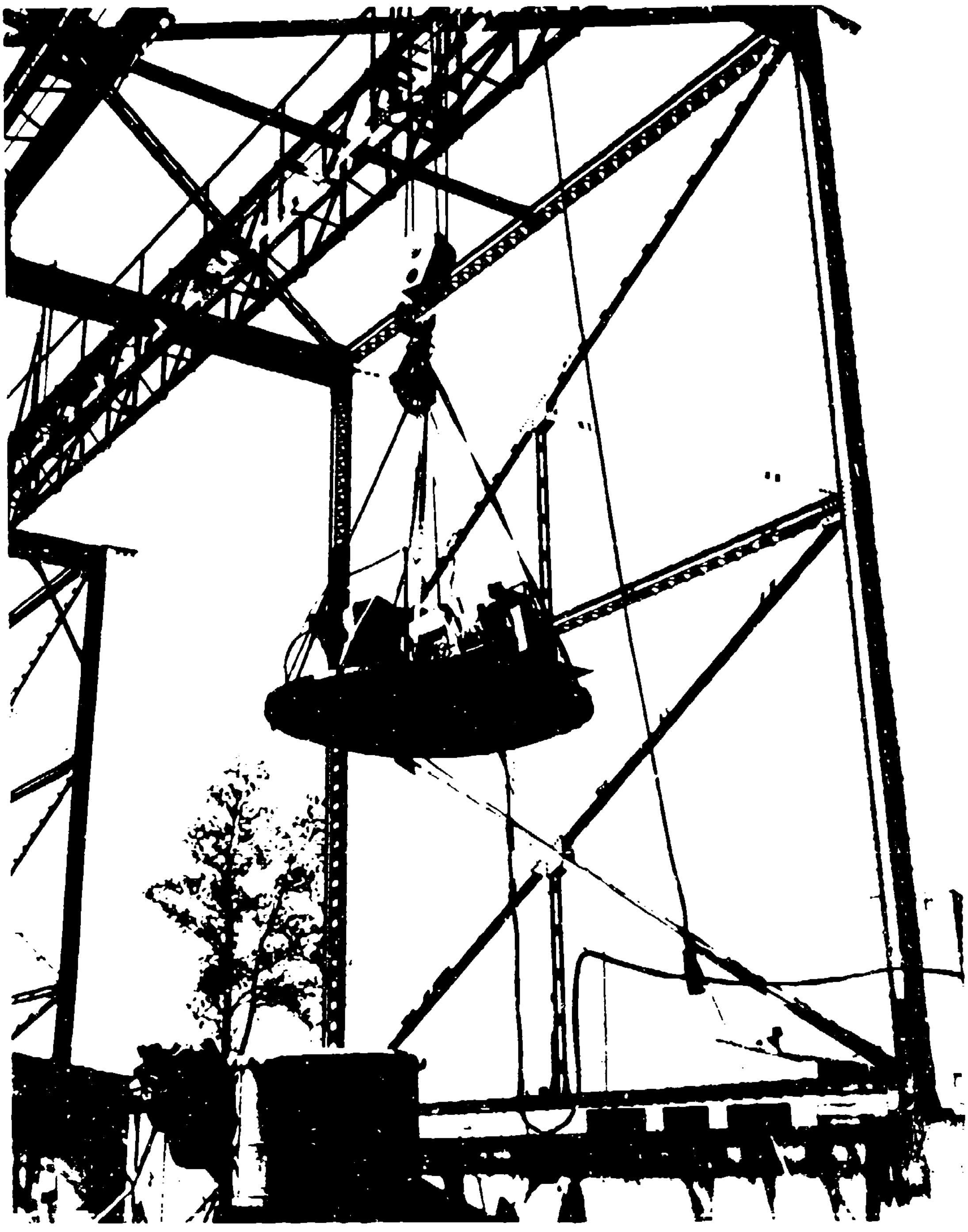


Fig IV-13 Human subject in Mercury couch mounted on a simulated impact attenuation device of the NASA Mercury spacecraft.

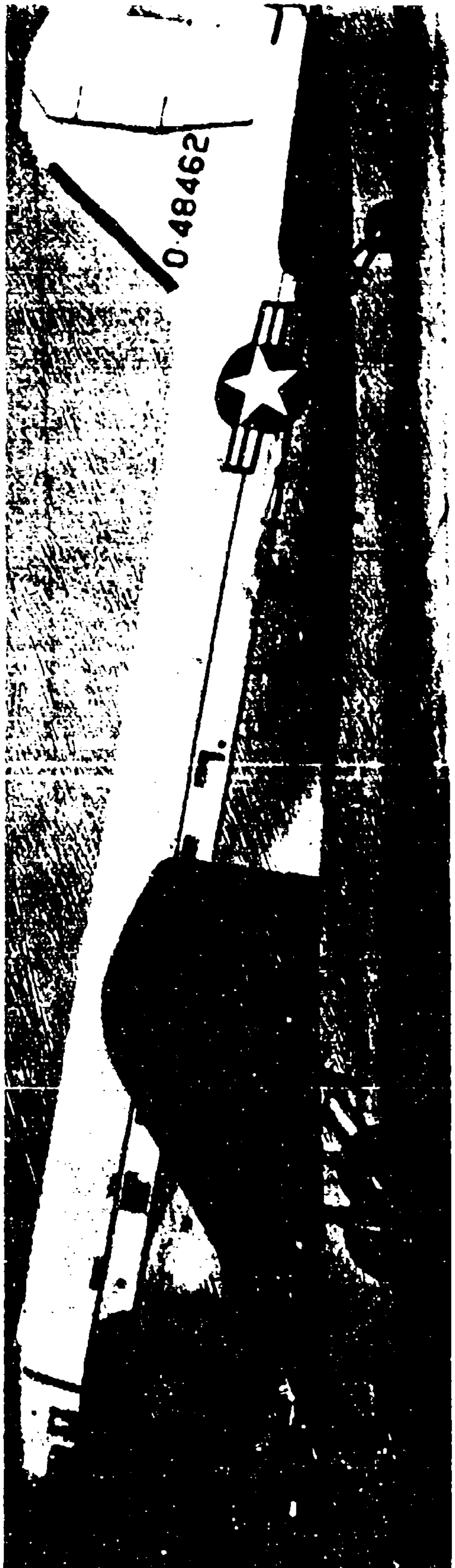
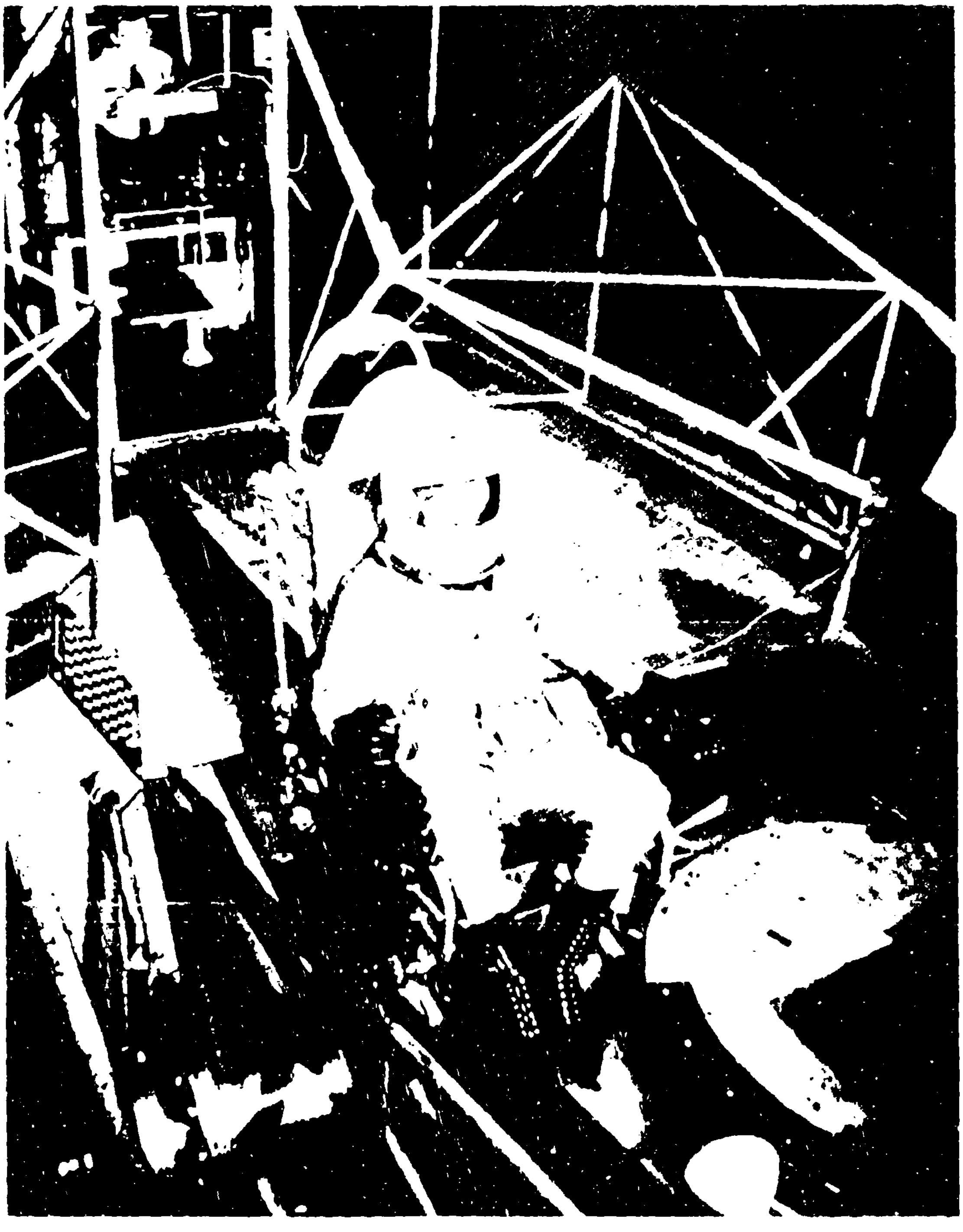


Fig IV-14 First C-47 used in the development of lateral firing guns program at Wright Field.



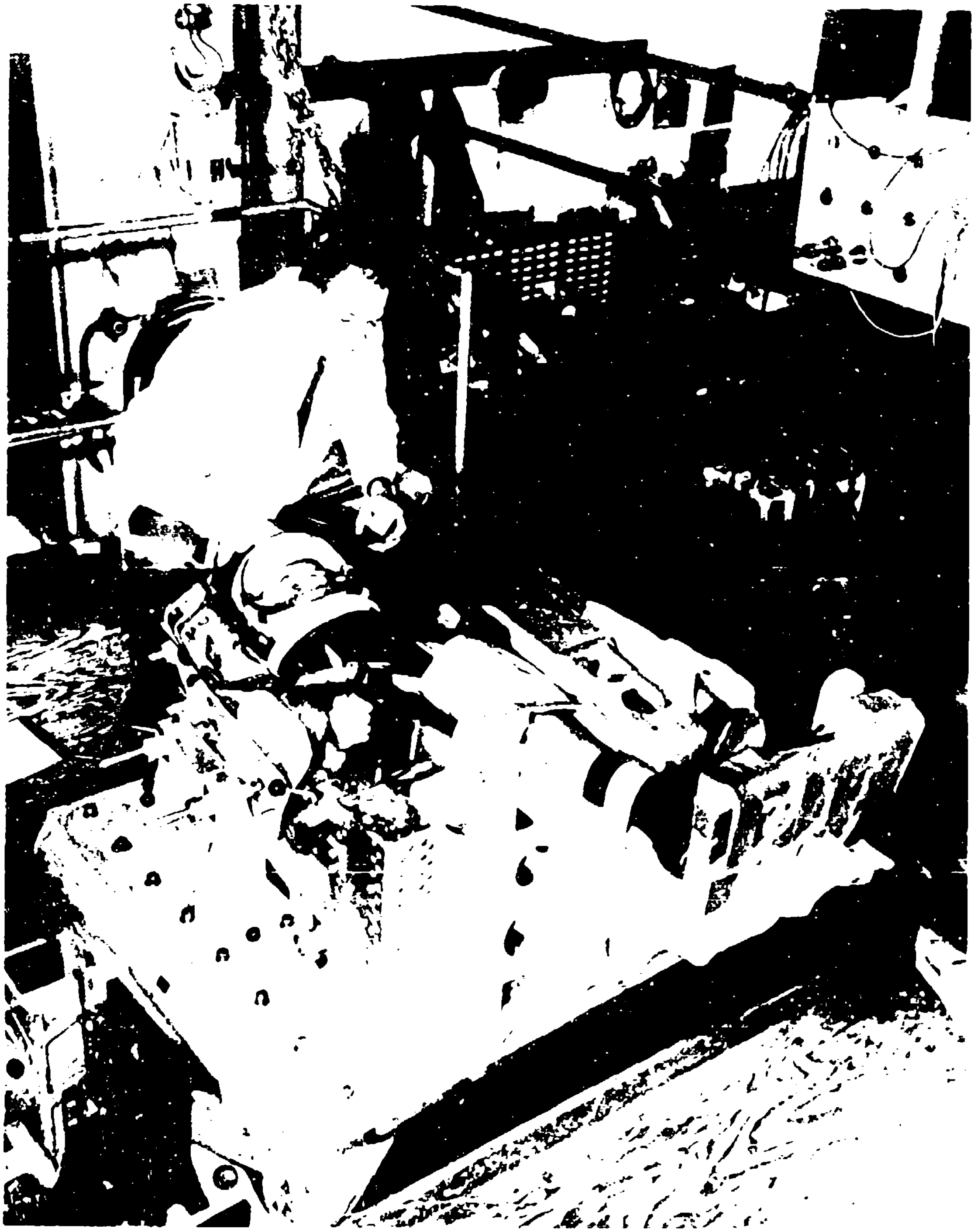


Fig IV-46 Captain George Mohr supervises the vibration test of the Apollo seat position while the subject wears the pressure suit.

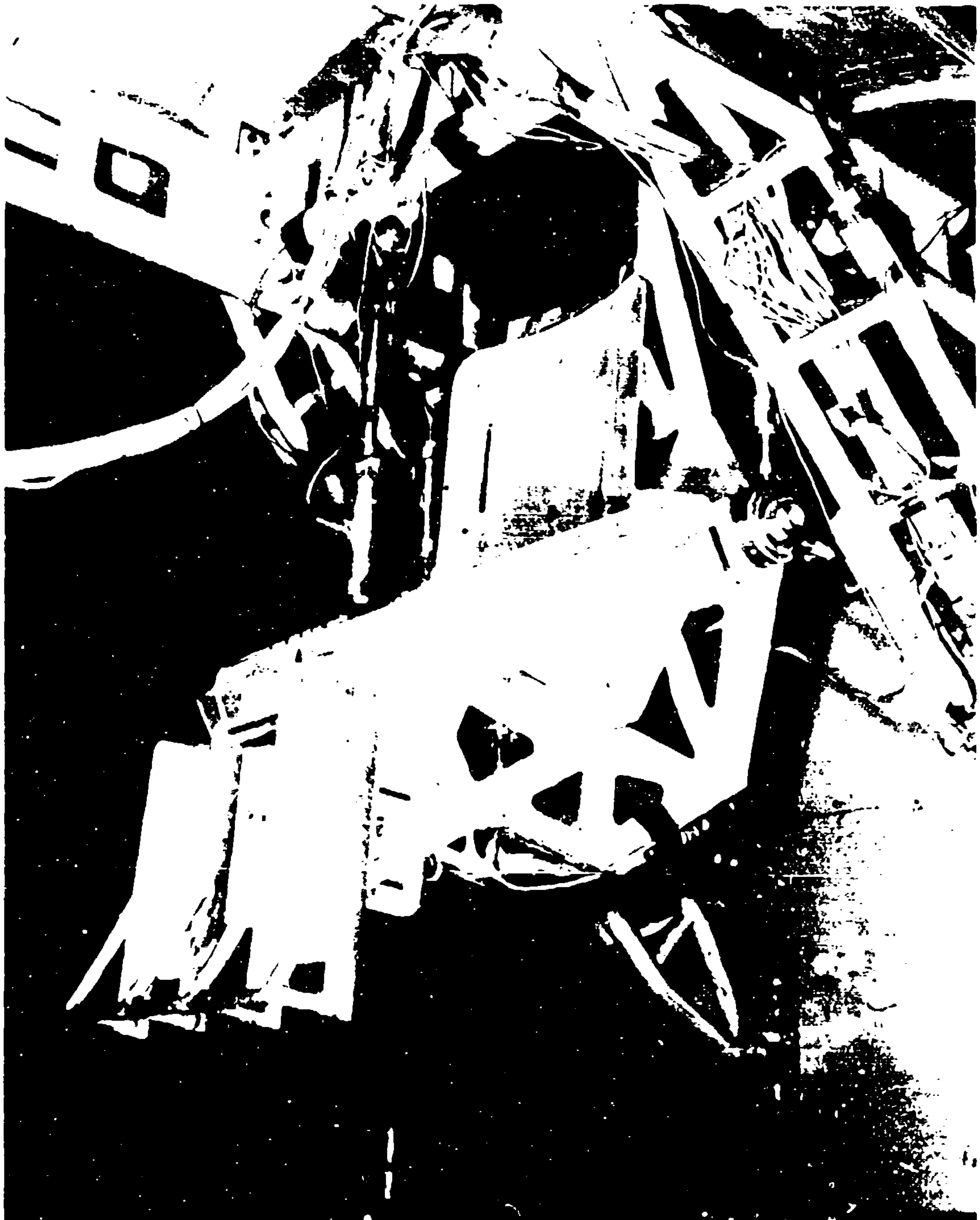


Fig IV-17 Abrupt landing impact tests of the Apollo seat using the vertical drop tower

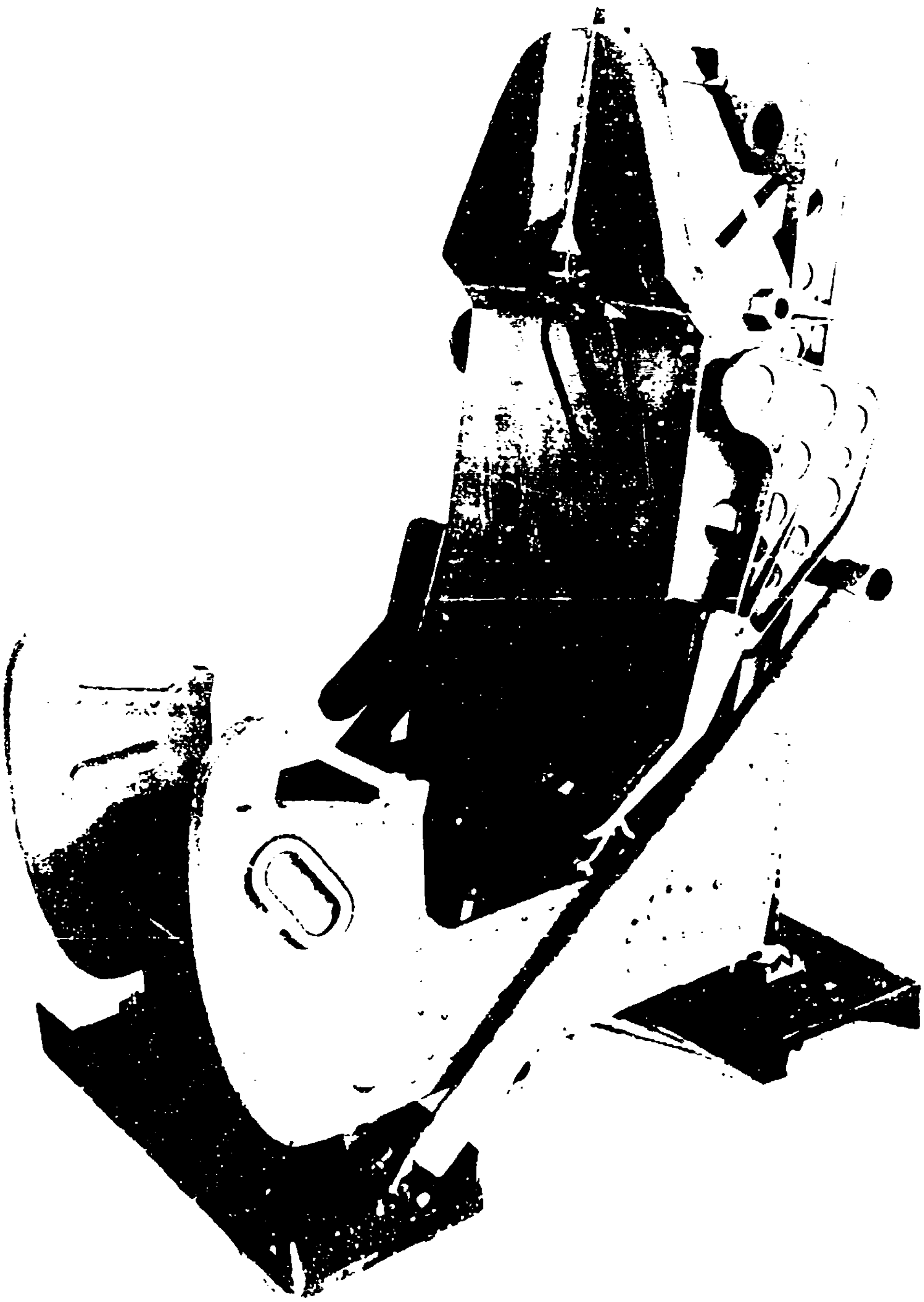


Fig IV-18 First operational tiltable ejection seat which was used in extended range flight experiments. The pilot did not leave this seat for 80 hours.

Fig. IV-19 This B-47 established a new world record for non-stop jet flight, 39000 miles in 80 hours. The pilot remained in the tiltable ejection seat for the entire flight.

Fig. IV-20 Captain Joe Kittinger at 102,400 feet in a free fall parachute experiment. He established a new world record in 1960 that has not been broken.

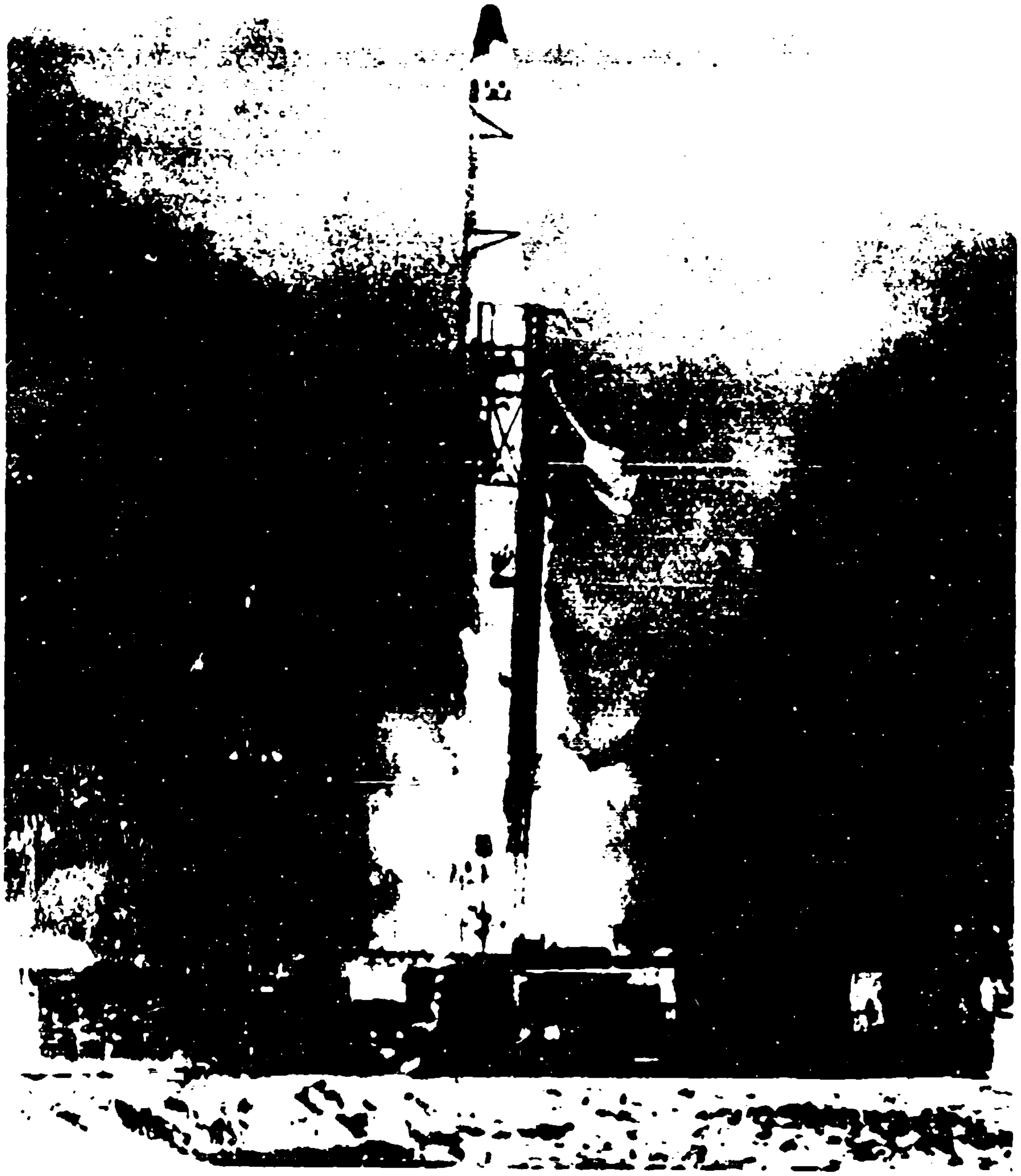


Fig IV-21 AMRL radiation protection experiment. Launched on Discoverer XXXII into polar orbit in 1961

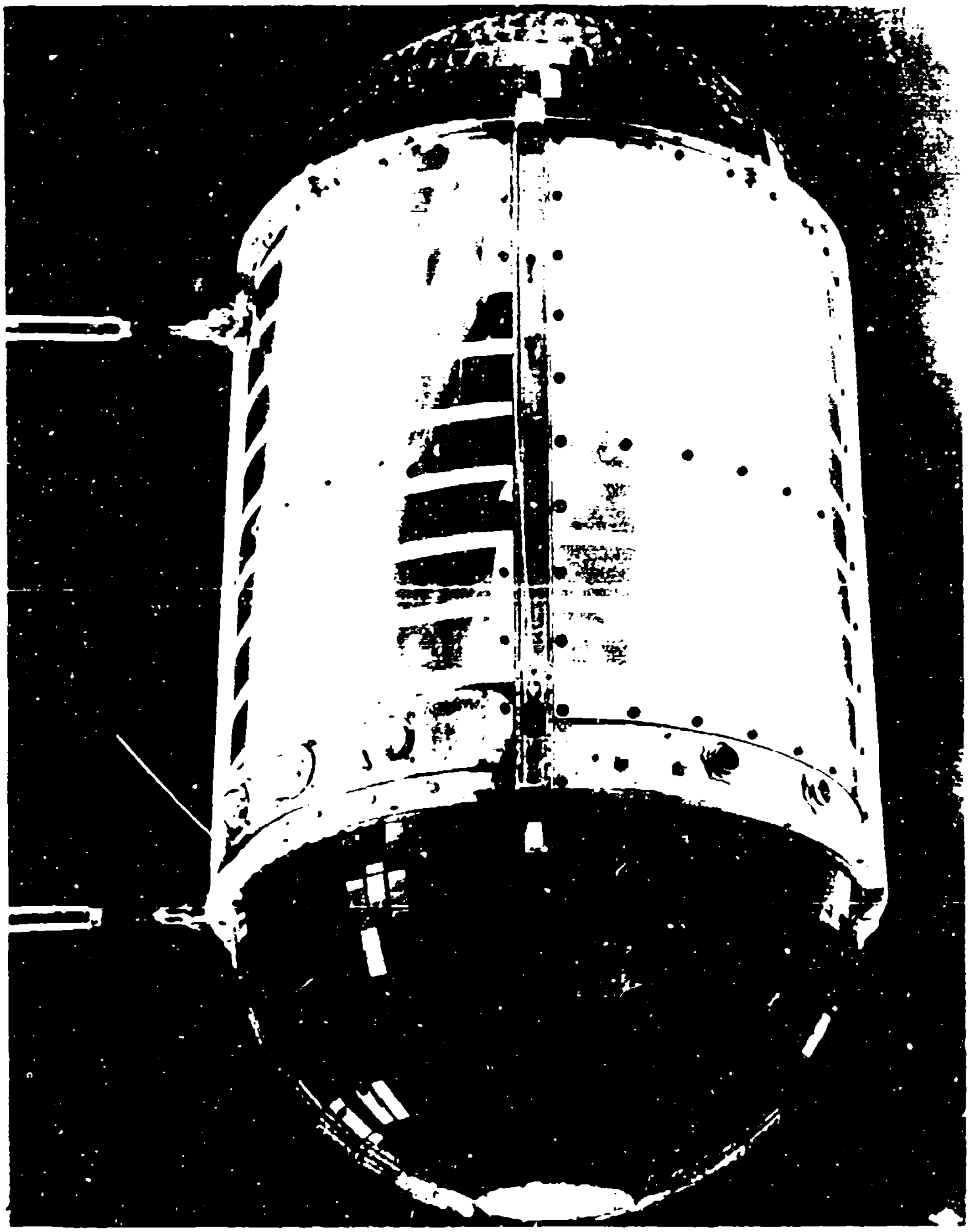


Fig IV-22 FESS radiation protection satellite. Launched in 1965, with a 225 NM perigee and a 1878 NM apogee. Mr. Speakman and Mr. Pittman.

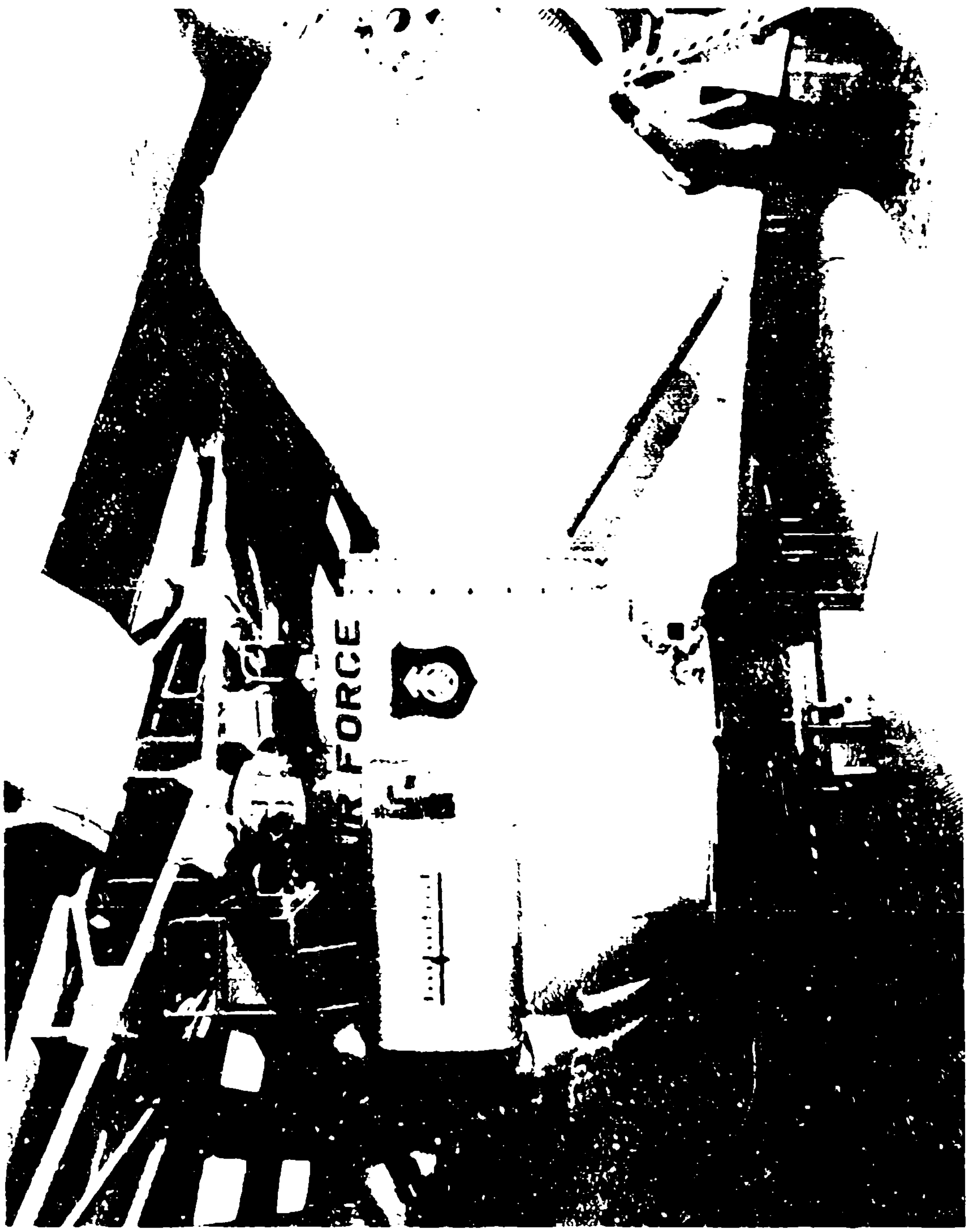


Fig IV-23 Fourth human centrifuge at Wright Field, 1969. This is the first USAF machine to have closed loop control for flight simulation.

Fig IV-24 Dr. VonGierke conducts a human equilibrium experiment in an intense sound field.

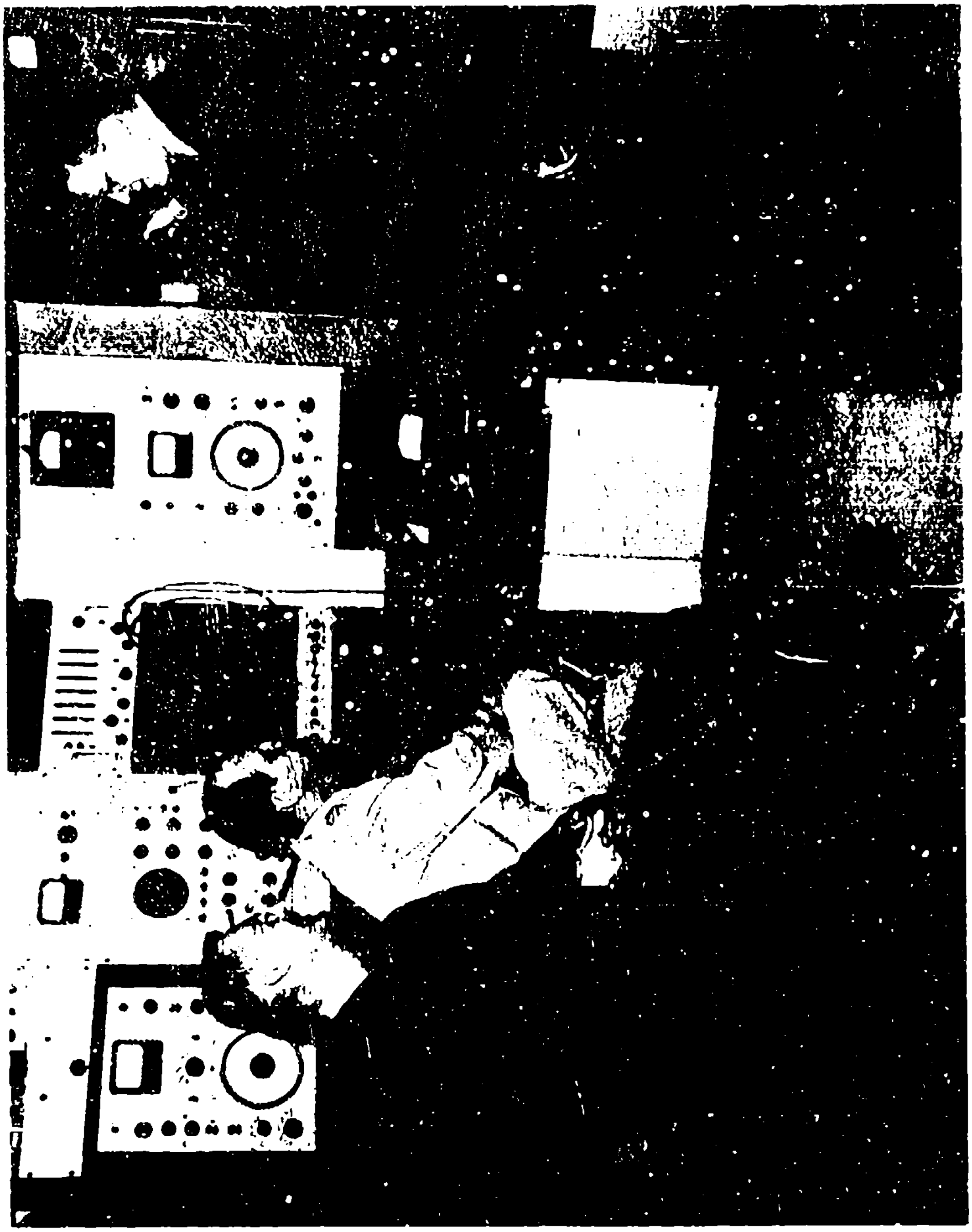


Fig IV-25 First word recognition experiments using an electronic model of the inner ear. Dr. Mundie, Dr. Oestreichier, Colonel Steele.

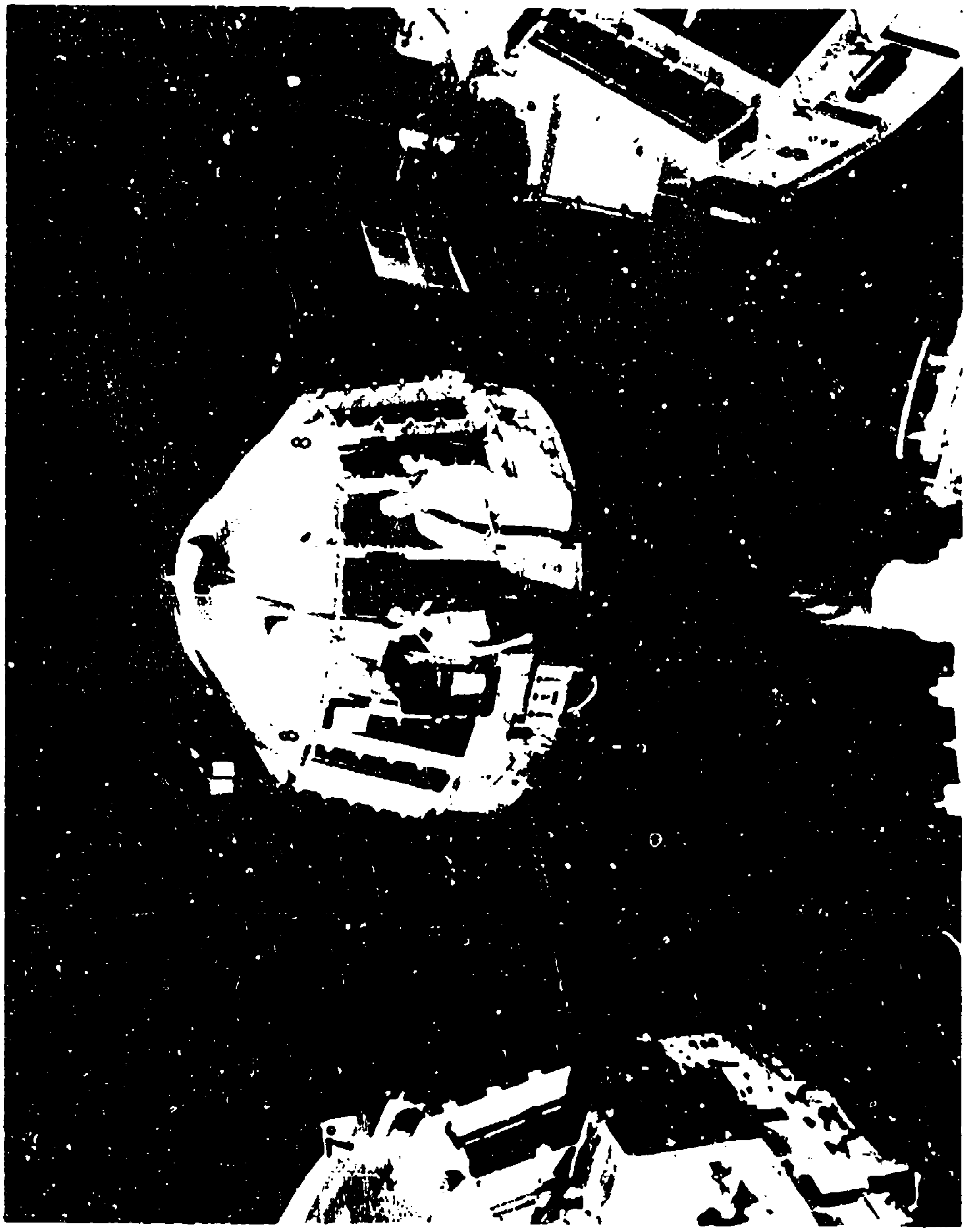


Fig IV-26 Dr. Thomas designed the new Thomas Domes in the toxicological research facility in Bldg. 79.

Fig IV-27 Human engineering systems simulator (HESS). This IBM 360-40 computer provides real time simulation for man-machine research.

Fig IV-28 Forty two day nutritional balance study. Using foods designed for long term space flight. Miss Finkelstein, Mr Metzger.

Fig IV-29 First helmet mounted sight was designed and tested in the Laboratory.

Fig. IV-30 The JWB-50 aircraft used in human engineering tests of reconnaissance equipment in Panama.

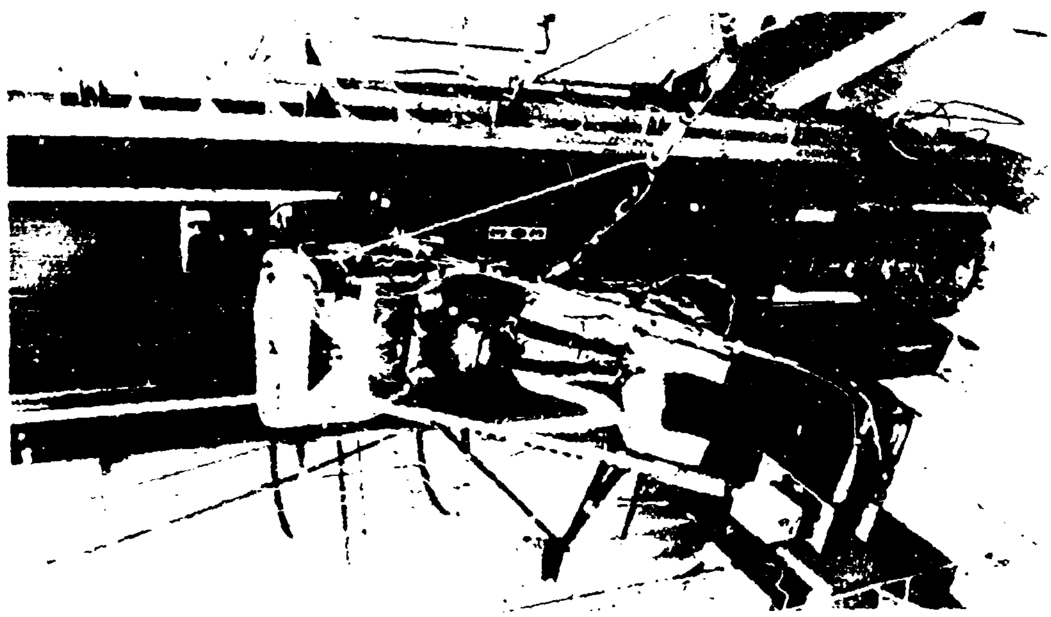


Fig IV-31 Vertical drop tower in Bldg. 824.

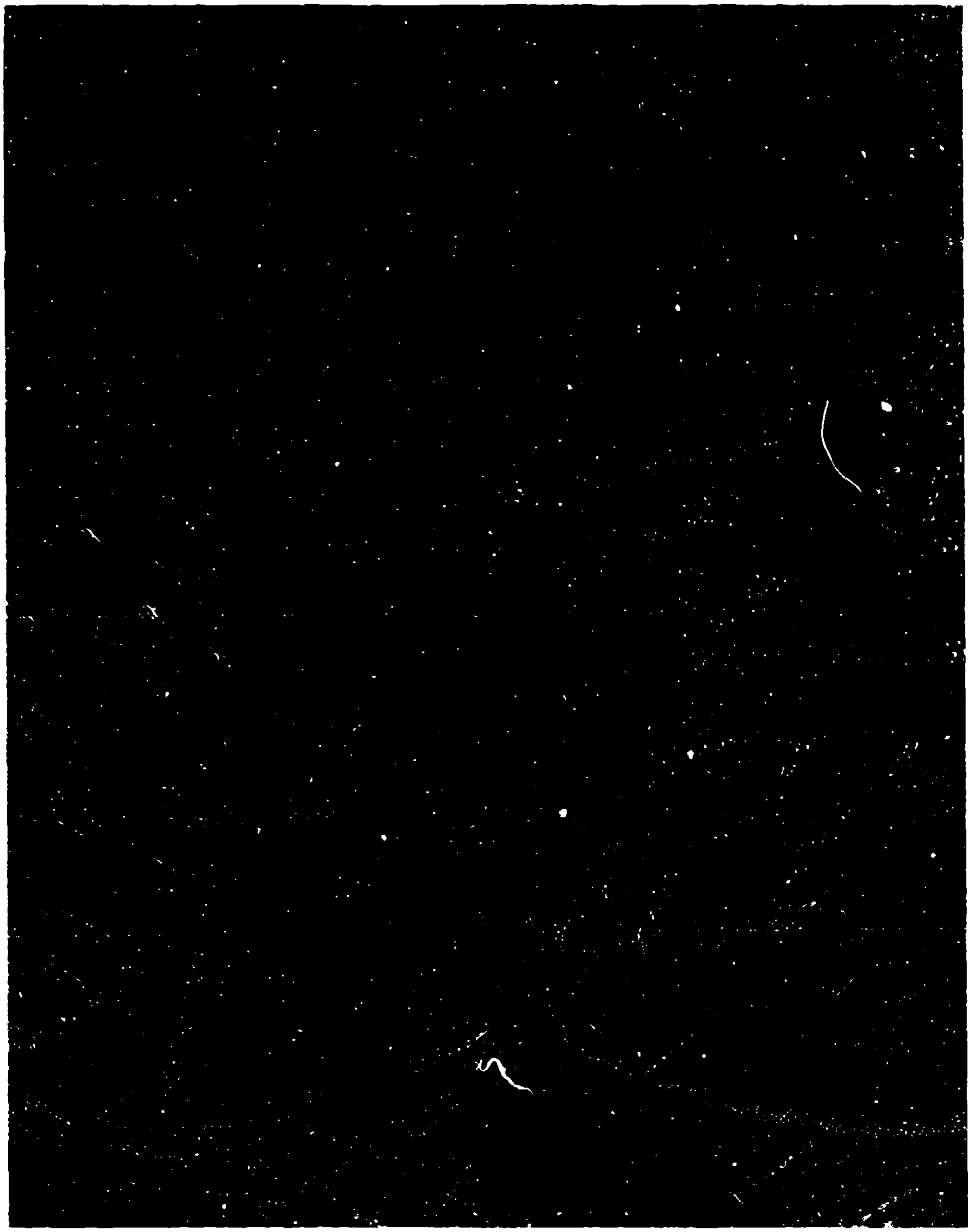


Fig IV-32 Human tests of HC-130H aerial retrieval system.

CHAPTER FIVE

ADVANCED FLIGHT RESEARCH 1970-1984

ORGANIZATION AND COMMAND

The Holloman Aeromedical Laboratory, its daisy decelerator, related equipment, and nine personnel were reassigned to the 6570th Aerospace Medical Research Laboratory on July 1, 1970.

Colonel Holt was appointed Commander, 6570th Aerospace Medical Research Laboratory on August 24, 1970.

The Technical Advisor Office was abolished in October 1971.

Mrs. Mae (Callen) Poszywak retired from the Air Force in 1971, after 32 years of service. She was the second civilian employee and the first full-time stenographer to be hired by Captain Armstrong in June 1939. Mrs. Poszywak had been responsible for all the administration activities in the Aero Medical Research Unit.

Mr. John Hall retired from the Laboratory in 1971, after 32 years of service. He was the third civilian employee to be hired by Captain Armstrong in September 1939. He worked as a physiologist in the Aero Medical Research Unit in the basement of Building 16.

The Laboratory was authorized a Vice Commander position in March 1972. Colonel Doppelt was appointed the first Vice Commander of the Laboratory.

Colonel Doppelt was appointed Commander, 6570th Aerospace Medical Research Laboratory in 1973.

Mr. Raymond U. Whitney retired from the Laboratory in June 1973, after 36 years of service. He was permanently assigned to work with Captain Armstrong in the Physiological Research Laboratory in 1937. He participated in the pioneering altitude chamber experiments, working directly with Dr. Armstrong. He also flew with Captain Armstrong in the pressurized cabin experiments in the XC-35 airplane. He was the first person in the Physiological Research Laboratory to receive the Distinguished Flying Cross for this pioneering work in the altitude chambers. He also participated in the altitude tests of the BOB oxygen mask with Dr. Lovelace and Dr. Boothby in 1938. Dr. Lovelace, Dr. Boothby and Dr. Armstrong received the Collier Trophy for this research and development work.

Dr. Walter Grether retired from the Laboratory in June 1973 after 32 years of service. Major Grether was the first officer assigned to work with Lt Col. Paul Fitts, founder of the Air Force Engineering Psychology program. Fitts and Grether organized and developed the broad based human engineering research program.

Dr. Melvin Warrick retired from the Laboratory in June 1973 after 31 years of service.

Dr. Julien Christensen retired from the Laboratory in 1974 after 33 years of service. Mr. Charles Bates replaced him as Chief, Human Engineering Division.

Mr. Ernest Martin retired from the Laboratory in 1975 after 33 years of service. He was called to active duty in the Aero Medical Research Laboratory as an aviation physiologist. He worked

in the original altitude chambers located in the basement of Building 16, the site of the Physiological Research Laboratory.

Colonel DeHart was appointed Commander, 6570th Aerospace Medical Research Laboratory, in 1976.

The Navy Medical Research Institute established a Toxicology Detachment in the Laboratory in July 1976.

In April 1977, there was a reorganization and renaming of the Biodynamics and Bionics Division. Those changes included: the new name, Biodynamics and Bioengineering Division, abolishing the Neurophysiology Branch, expanding the mission of the Biomechanical Protection Branch, and the Biodynamic Effects Branch, establishing a position of Director, Plans and Programs, in the Division office.

A functional and organizational realignment of the Environmental Medicine Division was accomplished on July 18, 1977. Those changes included: the new name Manned Systems Effectiveness Division, expansion of the mission of the Systems Technology Branch, the Analysis and Simulation Branch, the Simulation Support Branch, and abolishment of the Environmental Physiology Branch.

A Technical Services Division was established in September 1977. That action consolidated the Technical Operations Division and Support Services Division.

The Laboratory organizational name was changed from 6570th Aerospace Medical Research Laboratory to Air Force Aerospace Medical Research Laboratory, in 1979.

The Laboratory was reorganized in May 1979. The Manned Systems Effectiveness Division was abolished. Its research programs were distributed between the Biodynamics and Bioengineering Division and the Human Engineering Division. The Laboratory now had five operating divisions: Biodynamics and Bioengineering, Human Engineering, Toxic Hazards, Technical Services, and Veterinary Sciences.

Colonel Mohr was appointed Commander, Air Force Aerospace Medical Research Laboratory, in May 1980.

In 1982, two new Advanced Development Program Offices were established for management of the 6.3 programs: Crew Automation Technology (CAT), and the Crew Escape Technology (CREST)

U. S. AIR FORCE AIRCRAFT

F-4, F-5, F-15, F-16, F-106, F-111, B-1, B-52, C-141, C-5A
C-5B, C-130, KC-10, KC-135, SR-71, T-37, T-38, T-39, T-41
U-2, AFTI-16

NASA SPACECRAFT

APOLLO, SPACELAB, SPACE SHUTTLE

CHALLENGING AEROMEDICAL PROBLEMS

- Fully automated cockpit technology
- Voice control of cockpit functions
- Toxicology of rocket fuels in people and plants
- Visual standards of aircraft windscreens
- Chemical defense modeling of human capability

- Establishment of aircrew workload standards
- Human operator modeling of AAA threats
- Computer modeling of anthropometrics for workspace design
- Open ejection seat technology with protection to 1600 Q
- Computer modeling of escape system performance
- Secure tactical communications
- Environmental noise modeling for land use planning
- RPV multioperator real-time mission simulation
- High acceleration cockpit development
- Strategic systems crew station design
- Human engineering design of command and control systems
- Crew Survivability/Vulnerability model for weapon systems

PIONEERING ACHIEVEMENTS

- DES modified into a closed-loop manrated simulator (Mr. VanPatten, 7231, 1970)
- High Acceleration Cockpit research program initiated (Mr. Kulwicki, 7184, 1970)
- First airborne qualified Helmet Mounted Display (Capt James Brindle, 7184, 1970)
- Development of "stick-man" computer model (Dr. Kroemer, 7184, 1970)
- Initiation of the Optical Counter Measures program (Dr. Replogle, 431G, 1970)
- Development of drawing board manikins for NASA design program on the Space Shuttle (Dr. Kennedy, 718', 1970)
- Abrupt acceleration research program using automotive air bag restraints (AF/DOT) (Mr. Brinkley, 7231, 1971)
- First flight tests of the Helmet-Mounted Sight at Tyndall AFB (Mr. Furness, 7184, 1971)
- Completion of the first experiments involving combined heat,noise, and vibration stress using the DES (Dr. Grether, 7184, 1971)
- SACDEF strategic mission simulation program (Mr. Sharp, 7184, 1971)
- First centrifuge demonstration of pilot capability to withstand +9Gz in the F-15 cockpit configuration (Colonel Mohr, Dr. Leverett, 7231/7930, 1971)
- First computerized Anthropometric Data Bank established of U.S. military populations and allied military population (Mr. Clauser, 7184, 1972)
- Development of the Systems Analysis Integrated Network of Tasks (SAINT). First man system model for predicting nuclear S/V effects. Is used world-wide in man-machine simulation research programs (Dr. Chubb, Mrs. Seifert, 7184, 1972)
- The impulse accelerator manrated as an impact test facility in Bldg 824 (Mr. Brinkley, 7231, 1972)
- The largest scale inhalation exposure study ever performed in the THRU facility initiated to establish oncogenic dose-responses to hydrazine, unsymmetrical dimethylhydrazine and monomethylhydrazine (Dr. Back, 6302, 1972)
- Flight tests of the Long Line Loiter program successfully completed (Captain Simons, 7184, 1972)
- Visually Coupled Aids research organized into a 6.4 program (Project 5973) (Mr. Bates, 7184, 1972)
- The Helmet Mounted Sight successfully demonstrated in combat flight maneuvers and weapon launches at Tyndall AFB (Mr. Furness, 7184, 1973)
- The first real-time multioperator RPV mission simulation conducted using five operators (Dr. Mills, 7184, 1973)

- The SIXMODE a large six degree of freedom vibration table manrated (Captain Wilburn, 7231, 1973)
- First computerized graphics of anthropometric data for use in aircraft design (COMBIMAN) (Dr. Kroemer, 7184, 1974)
- First comprehensive research effort on the toxicology of halogenated fire extinguishing agents completed (Dr. Back, 6302, 1974)
- First flight test of Visually Coupled Airborne Systems Simulator (VCASS) for-air-to-air missile control (Captain Kocian, 5973, 1974)
- AMRL, AFFDL, ASD/ENC planning study and program plan for new advanced escape system (CREST) (Mr. Brinkley, Mr. Dempsey, 7231, 1975)
- F-16 canopy off windblast studies (Major Kendall, 7231, 1976)
- NOISEMAP transitioned to AFCEC (Mr. Cole, 7231, 1977)
- Motion cues research program for the design of flight simulators (Mr. Martin, 7184, 1977)
- Studies of the influence of fuselage proximity on limb flail forces. Windtunnel tests to MACH 1.2 (Mr. Specker, 7231, 1978)
- Development of human performance model for anti-aircraft threat systems (Dr. Replogle, 6893, 1978)
- The Visually Coupled Airborne Systems Simulator (VCASS) feasibility demonstration (Mr. Kocian, 7184, 1978)
- Chemical defense research program (Dr. Replogle, 2729, 1979)
- F-16 EPU hydrazine hazard analysis (Colonel Carter, 6302, 1979)
- F-111 windscreen standards established (Mr. Welde, Lt/Col. Genco, 7184, 1979)
- Transition of NOISECHECK technology (Mr. Cole, 7231, 1979)
- Nationally accredited animal facility with laminar air flow for lifetime holding of animals; annual animal population 12,000 (Colonel Bankneider, 1979)
- Electronic high-onset rate G valve (Mr. VanPatten, 7222, 1981)
- First initiative on C3 operator performance program (COPE) (Captain Poturalski, 7184, 1981)
- Voice communication research and evaluation system (VOCRES) (Mr. McKinley, 7231, 1981)
- Initiation of operator workload assessment program (Colonel O'Donnell, 7184, 1981)
- Effects of optical countermeasures on target acquisition (Captain Tutin, 6893, 1982)
- Interim factor X standard (Dr. McDaniel, 7184, 1982)
- Threshold Exposure Limits Recommendations for JP-10 fuels (Dr. BAck, 6302, 1982)
- Tactical Communications research program (Dr. Moore, Mr. McKinley, 7231, 1982)
- Voice control is flight tested in the AFTI/F-16 aircraft (Dr. Moore, 7231, 1982)
- Establishment of objective strength-selection criteria for all Air Force enlistees (Dr. McDaniel, 7184, 1982)
- Night vision goggle heads up display (Dr. Task, Mr. Craig, 7184, 1983)
- Established strength and endurance capabilities of men and women to operate aircraft controls (Dr. McDaniel, 7184, 1983)
- Visual Function Tester developed and flown aboard the space shuttle (Lt Col. Genco, Dr. Task, 7184, 1984)

PROJECT	NUMBERS	TITLES
6.1	7163	Toxicity of AF Chemicals and Materials
	7183	Psychological Research on Human Performance
	7220	Predicting Aircrew Performance in Stress
	7230	Basic Mechanisms of Mechanical Energy
	7232	Basic Biological Principles and Mechanisms
	7233	Applications of Biological Principles
	2312V1	Toxicity of AF Chemicals and Materials
	2312V2	Human Operator Performance Models
	2312V3	Basic Mechanisms Mechanical Energy
	2312V4	Basic Biological Principles and Mechanisms
	2312V6	Experimental Studies of Human Controller
	2313V1	Psychological Research on Human Performance
	2313V2	Basic Vision Research
6.2	2729	Chemical Defense Analysis
	6302	Toxic Hazards of Propellants and Materials
	6373	Equipment for Life Support in Aerospace
	6893	Crew Factors in Countermeasures and Threat
	7164	Thermal Effects and Altitude Protection
	7184	Human Engineering for Air Force Systems
	7222	Combined Stress Environments
	7231	Biomechanics of Air Force Operations
6.3	2722	Chemical Defense
	2829	Cockpit Automation Technology (CAT)
	2868	Crew Escape Techniques (CREST)
6.4	5973	Visually Coupled Aids

FACILITIES

Evans & Sutherland Picture System	Bldg 33
Neuromagnetometer	Bldg 33
Dynamic Environmental Simulator	Bldg 33
MPSS Simulator	Bldg 33
C3 Threat Simulator	Bldg 33
SAM Simulator	Bldg 33
AAA Simulator	Bldg 33
Roll-Axis Tracking Simulator	Bldg 33
Visual Flight Research Simulator	Bldg 33
Flight Simulation Laboratory	Bldg 33
Motion-Base Simulation Facility	Bldg 33
Dynamic Strength Test Cockpit	Bldg 33
Hercules	Bldg 33
Beckman TOXSYS Automated Record System	Bldg 79
Thomas Domes	Bldg 79
Toxic Hazards Research Unit	Bldg 79
Necropsy Room	Bldg 79
Contrast Sensitivity Measurement Lab	Bldg 196
Visual Evoked Response Laboratory	Bldg 196
VIPER	Bldg 248
VCASS	Bldg 248
Helmet Mounted Oculometer Facility	Bldg 248
SACDEF	Bldg 248
C3 Prototype Workstation	Bldg 248
SACDEF Simulator	Bldg 248
HESS Simulator	Bldg 248

NOISEBANK	Bldg 441
MOBILE LAB	Bldg 441
Acoustic Data Acquisition Systems	Bldg 441
Speech Synthesis System	Bldg 441
VOCRES	Bldg 441
Auditory Evoked Response Laboratory	Bldg 441
Body Positioning and Restraint Device	Bldg 824
Horizontal Decelerator	Bldg 824
Impulse Accelerator	Bldg 824
Deceleration Tower	Bldg 824
Impact Machine	Bldg 824

Flight test aircraft

JWB-50	Human Engineering Division
JC-131	Human Engineering Division
JC-121	Human Engineering Division
P2-V	Human Engineering Division
F-4	Human Engineering Division
A-7	Human Engineering Division
F-101	Human Engineering Division
F-106	Human Engineering Division
JKC-135	Human Engineering Division

THE LABORATORY PROGRAMS

OVERVIEW

The technical direction of Air Force weapon system development began to make a fundamental change in this period. This change was as dramatic as the shift from propellers to jets in 1946. The change at first was slow and almost imperceptible, but it began to accelerate in the first three years and became a full fledged storm around 1975. The change was entirely based on the advent of low cost, highly reliable, computer technology. The engineering community at Wright Field was quick to exploit and further develop this fast moving technology.

This technical advance had two major elements that would significantly drive the overall technical program of the Laboratory. The first element was the explosive advance in avionics technology. Avionics achieved a breakthrough in design, production and reliability which had a direct effect on military aviation. The mission capability of the weapon system was now measured in inches rather than yards from the target. Target acquisition, threat warning, and jamming in real time became a mission reality instead of a hit and miss proposition. Human performance was now pushed to the limit and combat aircrews were often overwhelmed with information processing and decision making. The avionics technology also opened up new approaches for human engineering to evolve technology that would improve the pilot's performance and reduce his workload. The Human Engineering Division did outstanding work in managing this major technology change, pursuing new initiatives, and supporting the engineering community.

The second element was the rapid advance in aircraft design and propulsion technology. The new computers permitted preliminary and detailed aircraft design work, structural analysis, and the integration of aerodynamics and propulsion technology. Sophisticated graphics packages permitted real time simulations of flight profiles, structural loadings, and pilot interactions. All of this work could be accomplished in the Laboratory. The need for construction and testing of many major subsystems parts was greatly reduced. This new capability for design engineers produced advanced weapon systems with performance envelopes which were at or beyond the border of human tolerance to the physical environment. Significant increase in cruise airspeeds made ejection and windblast limits often beyond human tolerance. These speeds with excess thrust capability at all mission points made 9G combat turns a routine maneuver instead of an accidental event. More powerful engines also created new problems in community noise.

The A M R L response to this computer driven change in technology was a gradual realignment of the technical program. This realignment process necessitated a restructure of the overall technical program into packages identified as thrust, core and support. The manpower and funding resources had to be adjusted to meet the challenge. This shift in program began to create centers of technology with specific goals. The thrust goal was aimed at the future weapon system developments and technology with specific endpoints. The core programs were basic technology that would in a more relaxed time frame provide new knowledge to the thrust program. The support program was the quick assistance to the engineering world when technolgy advanced at a faster pace. Within all the Laboratory research programs there was also a shift to the use of computer technolgy. There was significant growth of in-house simulators and they rapidly became more sophisticated and very complicated research devices. Biotechrology modeling was introduced on a grand scale for both human engineering and physiology. Human testing was no longer "cut and try" but more of a prediction with limited testing at certain junctions to check data validity and verify future postulates. In 1946, a subject would ride an ejection seat up the 100 foot ejection tower on the sidewall of the static test building. Major attempts were made to gather reliable acceleration and physiological data during the rather brief event. Today the Laboratory is able to computer model the entire event and watch the computer graphics present every body motion in slow time. This computer modeling also permits exploration into an area where the environment or circumstance would be fatal for actual human test. This major technology advance did one other thing: it permitted the application of biotechnology data in specific quantitative terms similar to engineering data. Biotechnology was now on a par with the engineering world and in many instances exceeding them in knowledge.

The greatest impact of this computer revolution was on the Human Engineering Division. They did a superb job of managing the change and focusing their research program on the reality of the need that was being thrust upon them on a daily basis.

The Aerospace Medical Division established a new policy of developing and managing 6.3 advanced development programs. They created an Advanced Development Directorate and initiated new technical programs. Three of these programs were assigned to the Laboratory. Advanced Development Program Offices were formed in the Laboratory and personnel were assigned to the programs.

The Laboratory Commander initiated a fundamental change in the technical management of the Laboratory programs. Under his direction and leadership the Laboratory for the first time in its history was automated through the use of computer technology. The technical program was repackaged into major thrust and core technology. This activity was carried down to the workunit level. This change was then integrated into a computerized management information system. This Laboratory level Management Information System (MIS) permitted comprehensive planning, program adjustment, and accurate tracking of the funding and manpower resources. It also permitted daily review of any significant changes that were occurring in the program. The Commander and Technical Council could now take effective action on any problems which might arise prior to the development of a major impact on Laboratory resources. The major thrust efforts also permitted the Laboratory to compete with the overall future direction of the Air Force and the engineering planning agencies in a more timely manner.

SELECTED PROGRAMS

The DES was modified to provide closed loop control up to 7.5 G. This increased capability permitted new research on human performance in chemical defense, advanced flight vehicle performance, and the testing of technical problems in aircraft design or flight missions (Mr. VanPatten, 6893 1970)

Anthropometric research was initiated on a program to develop computerized models of the man to be used in the support of aircraft design. (COMBIMAN) The effort included as an objective the acquisition of data on functional body-segment length and the measurement of paths of movement of body-segment joint centers. Other objectives sought to determine segmented mass and centers of mass of human body segments as well as to determine body contour and the digital angular lengths. Measurements were also to be made of muscle strength on the body in typical use of flight controls (Dr. Kroemer, 7184, 1970)

The High Acceleration Cockpit (HAC) program was initiated to significantly improve pilot performance and the cockpit working environment of advanced design fighter aircraft. Those

aircraft beyond the F-15 had the capability for sustained +9 Gz combat turns and excess thrust availability. This flight environment exposed the pilot to multiple acceleration situations on a single flight. He would now spend significantly more time flying and fighting in the high acceleration environment. Using the tiltback seat concept introduced in the F-16, a high technology cockpit was evolved. This cockpit optimized the pilot working environment and provided the opportunity to ameliorate the acceleration effects. The research program was transitioned to the FDL 6.3 advanced development program on the AFTI/16 (Mr. Kulwicki, 7184, 1970).

The helmet mounted sight completed 27 successful flight tests in the F-101 and 71 tests in the F-106. These tests flown at Tyndall AFB Florida, were used to determine the utility of the HMS under high G conditions in acquiring and tracking a target. Live missiles were launched in this program. The success of this program led to the authorization in February 1971 of Project 5973, Visual Coupling Aids. This new 6.4 program enabled the Laboratory to perform the engineering development of visual-coupling aids for fire control, weapon delivery, reconnaissance, navigation, and flight control applications (Mr. Furness, 7184, 1971)

A major milestone in the National Highway Safety Program was achieved with the completed 35 impact tests using volunteers to determine the efficiency of automotive air bag restraint system during simulated automobile barrier crashes at velocities up to 30 MPH. The air bag system consisted of a pneumatically deployed double bag that was designed to be positioned under the instrument panel of a passenger car. No injuries or mechanical failures were experienced during this program and audiometry tests of human subjects proved that the intense low frequency impulse noise associated with air bag deployment posed no risk of hearing loss. This series of tests were the first to use human subjects with a near-production prototype air bag restraint that did not require the use of a lap belt (Mr. Brinkley, Dr. Nixon, 7231, 1971)

At the request of Brigadier General Bellis, Director, F-15 SPO, AMRL/USAFSAM conducted a research program to determine human capability to the higher operational accelerations in new combat tactics. Wearing standard personal protective equipment, and seated in a simulated F-15 cockpit position, thirteen subjects were exposed to +9 Gz for 45 seconds. Using a physiological straining maneuver in conjunction with their G-suit inflation, these subjects tolerated the high acceleration without loss of central vision. This program represented a record achievement for tolerable acceleration exposure. These data were used in the first preliminary design of the F-15 airplane (Colonel Mohr, Dr Leverett, 7231/7930, 1971)

Representatives from AMRL and Surgeon General's Office met at WPAFB and completed the revision of AFR 160-3, Hazardous Noise Exposure. The revised regulation was broadened in scope to include criteria for limiting exposures to infra-sound, ultrasound, and impulse noise as well as the normal audio range noise. Criteria were spelled out for minimizing hearing damage risk, interference with communication, and undesirable whole body effects. It also provided for the simplification and improvement of procedures for evaluating ear protector performance and noise hazards (Dr.Von Gierke, Dr. Nixon, Mr. Cole, 7231, 1972)

The Laboratory established an extensive anthropometric data bank. This computerized effort stored data from 11 anthropometric surveys of U. S. military populations and 7 surveys of allied military populations. The data included dimensions on more than 50,000 subjects, including about 2,000 women. This international data bank was a first in the field of anthropology. It provided the capability to use standard computer programs for carrying out a wide variety of data analyses, such as correlation, multiregression, factor analyses, and generation of bivariates and trivariates. It also provides for the development of sizing systems based on key dimensions (Mr. Clauser, 7184, 1972)

The Visually Coupled System (VCS) has its genesis in two highly related efforts: the Helmet Mounted Sight (HMS) and the Helmet Mounted Display (HMD). The functions of the HMS are to provide wide off-boresight weapon aiming, short reaction times, hands-free head-tracking and allow natural use of the head tracking abilities. It does this by projecting a sight reticle on the pilot's visor, measures the line of sight of the reticle and outputs the line of sight to applicable aircraft subsystems. The HMD receives video signals from aircraft subsystems, generates an image on a small cathode ray tube and projects the image to the pilot's eye. The HMD provides the advantages of a large screen head up display, sufficient image quality and can be continuously

presented with no requirement for instrument panel space. Combining the two technologies in effect "couples" the visual display system and improves the use of the visual system as a control mode also. It yields a low cost visual fire control system and increases the effectiveness of existing weapons as well as provides new ways of accomplishing traditional functions of navigation and target acquisition. (Mr. Bates, Dr. Furness, 7184, 5973, 1972)

Flight tests of the Long-Line Loiter program were successfully completed at Eglin AFB, Florida. This program demonstrated a point of delivery and pick-up system from a stationary point on the ground while the aircraft was flying an on-pylon turn maneuver. Interruption of the pylon turn brings the stablized ground point of the line in to trailing tow. This flight maneuver permits the Air Force to use the system as a rescue and retrieval technique for downed airmen and to use fixed-wing high speed aircraft instead of helicopters (Captain Simons, 7184, 1972)

Remotely Piloted Vehicles (RPV) began to evolve as fundamental weapon systems which could be used against highly defended targets. In such military missions, the use of multiple RPV in a single attack presented a major opportunity for mission success. The use of such a flight formation at low altitude, in a highly jammed avionics environment, had never been attempted by the Air Force. At the direct request of the RPV System Program Office, a multioperator real-time RPV mission simulation was conducted on the HESS. This research used five operators, individually flying their own RPV, in a mass formation with four midcourse corrections to specifically designated targets. The narrow band communications link and jamming were also used in this simulation. The result of this work was presented to the RPV System Program Office (Dr Mills, 7184, 1972)

NASA requested research on long term toxicity of methyl isobutylketone and freon 113 under conditions of continuous exposure in space cabin atmosphere. Both of these solvents had been found in vapor form in the cabin atmosphere of Apollo flights (Dr. Back, 6302, 1974)

The largest scale inhalation exposure study ever performed in the Toxic Hazard Research Unit (THRU) was initiated to establish oncogenic dose-responses to hydrazine, unsymmetrical dimethylhydrazine and monomethylhydrazine. The experiments involved six months to one-year exposures of mice, rats, hamsters, and dogs to graded concentrations of each missile fuel and lifetime postexposure holding of animals. Complete histopathological work-up involved the evaluation of over 300,000 tissues according to the protocol designed by the National Cancer Institute. The exposure period for the three fuels covered a three year span, with histopathology completion date in CY1979 (Dr. Thomas, 6302, 1974)

AFAMRL, AFFDL, and ASD/ENEC initiated a planning study and program plan for the development of an advanced escape system that would meet the technical requirements of future weapon systems. This program provided for a 6.2 research program which then would transition into a 6.3 advanced development program. The results of this test activity would transition to a 6.4 engineering development program. The specific technical programs in all program element areas were identified along with schedules and resources. The results of this work became the 6.3 program CREST (Mr. Brinkley, Mr. Dempsey, 7231, 1975)

This research evaluated the ability of pilots to recover the F-16 aircraft after inadvertent canopy loss. A wind tunnel test program was completed using F-16 fighter pilots as volunteer subjects in a full-scale forebody of an F-16. Protective maneuvers were developed to enable the pilot to regain control of the aircraft. A second test was conducted at Edwards AFB using a TF-15 without its canopy to examine the potential hazard to rear seat crewmembers in the event of canopy loss. An instrumented dummy and then a human subject (Major Wayne Kendall, Jr.) were flown in an open cockpit to 5000 feet and 415 knots. Dr. Kendall avoided injury by adopting the techniques developed in the F-16 wind tunnel tests (Major Kendall, 7231, 1976)

This research program investigated the influence of the F-16 fuselage and cockpit configuration on the aerodynamic forces which act on an ejecting crewmember. One-half scale models of an ejection seat, and an F-16 forebody and cockpit section were tested in a transonic wind tunnel at MACH numbers from 0.4 to 1.2. Crewmember extremity force measurements were taken beginning with the crewman/seat model positioned in the full-down, pre-ejection position in the cockpit and then repositioned and predetermined intervals until seat rail separation had occurred. The flow over the forebody was found to increase the magnitude and direction of the forces acting on the various limb segments. (Mr. Specker, 7231, 1977)

Toxic Hazards Division-NASA Space Shuttle environmental effects research program was initiated. It was directed to missile launch activities where large amounts of toxic products are found in the exhaust plume. The work determines the most potent toxic products occurring in the exhaust plume and exposures of selected plant species to these products. The results of the research provide information on environmental pollution and the impact of these rocket launches on the agriculture industry. Environmental work has also been accomplished on the fish industry (Captain Lind, 6302, 1977)

Theoretical biodynamic investigations have led to a detailed integrated picture of the mechanical properties of the human body and its responses to mechanical forces, particularly by means of a sophisticated computer model of the body. This provided a sound basis for biodynamic injury prediction and unified the field of biodynamics. Symposia with international participation were held at AMRL on two different occasions (Dr. von Gierke, Dr. Oestreicher, Dr. Kaleps, 7231, 1970-1977)

Chemical defense research program was initiated in the Laboratory. The Laboratory Commander appointed Dr. Replogle to serve as the overall coordinator. The research approach was to assess the system impact of degraded personnel operations caused by CW stressors such as low dose effects, protective ensemble deficiencies, and thermal burden. An operations research and human factors program was initiated to create an Air Force capability for analytical assessment of operations in a CW environment. The modeling and analysis capabilities included CW agent effects, air base systems assessment, task-time degradation and risk analysis. The program was supported by a CW data base consisting of a computerized annotated bibliography which has over 5500 documents. The data base was used throughout DOD and industry (Dr. Replogle, 2729, 1979-1984)

Minimum vision requirements for aircraft transparencies became an important Air Force need with the development of polycarbonate windscreens. Previously accepted optical standards were difficult to achieve with this material and the flight environment it experienced. Typical problems were complex curvatures, high angle of incidence to provide optimum aerodynamic shaping, composition of the multi-layered materials for bird strike protection, and the radar reflective coatings. This program concentrated on the optical variables of distortion, surface haze, and the secondary effects of multiple images, rainbowing, and light transmission. Human vision and performance studies were conducted to gather data and windscreen specification techniques. Other work included analysis of windscreen geometrics, and new optical measurement procedures. A new minimum vision specification was established in cooperation with the Air Force Flight Dynamics Laboratory (Lt/Col. Birt, Dr. Task, 7184, 1979)

The Tactical Aircraft Cockpit Development and Evaluation Program (TACDEP) consolidated the pilot factors data base and developed a low cost man-in-the-loop simulator. The simulator permits the development of quantitative pilot workload/performance measurements and the demonstration of advanced control/display concepts. In the data base area the acquisition and consolidation of all information processing and psychomotor control knowledge has been organized into a handbook, Integrated Perceptual Information for Designers (IPID) (Dr. Furness, 7184, 1980)

In January 1980, the Human Engineering Division of AFAMRL received a request from Headquarters, North American Aerospace Defense Command (NORAD) for technical assistance in evaluating human engineering at the NORAD Missile Warning Center (MWC). In response to that request, AFAMRL conducted a thorough investigation of the MWC which considered human factors such as lighting, noise, and man-machine interfaces. The assessment concluded that noise, facility layout, display quality, and display content could be significantly improved. Recommendations included developing a new operations concept that emphasized the relationship between crew members and the systems and operational conditions they worked in. The MWC assessment proved to be the beginning of a long working relationship between NORAD and AFAMRL. In the year following, AFAMRL personnel again were invited to NORAD, this time to conduct a Human Factors Engineering assessment of the NORAD Command Post. The report of that assessment was published in April 1981. Some recommendations contained in that report were immediately implemented. The implications of remaining issues, however, suggested that a larger effort, leading to eventual upgrade or replacement of the facility was warranted. As a result, AFAMRL provided a more extensive analysis and development of design concepts for a new Command Post. By 1983, AFAMRL

support included a survey of human factors affecting the ADCOM Intelligence Center at NORAD. AFAMRL HE supported NORAD (now Space Command/NORAD) in the laboratory as well. An investigation of the characteristics and applications of large displays, begun in 1983, contributed to the more effective design of command centers at Space Command and throughout the Department of Defense. Another example is the Human Engineering Division's design and construction of an advanced integrated workstation to demonstrate the potential application of advanced technologies and techniques to specific Space Command needs and feed the design of Space Command/NORAD workstation of the future (Captain Poturalski, Mr. Vikmanis, Captain Leupp, 7184, 1980-1984)

The Tactical Communications research program conducts empirical investigations of conventional and novel audio jammer effectiveness based on measures of human performance in realistic system and noise environments. This work has developed novel audio jamming modulations to exploit signal processing principles used by the auditory nervous system as determined by experiments conducted under the by-now-cancelled bionics research program. Work continues to explore high quality digital voice, voice control/voice response in the tactical cockpit environment (Dr. Moore, 7231, 1982)

The current innovations in aircraft technology (e.g. integrated digital fire/flight control systems, automation aids, voice actuated controller, etc.) have dramatically shifted the nature of the activities performed by people from that of "manual control" to one of "management" of a set of automated or semiautomated functions. The new reliance on automation in future systems must change the designer's conception of the role of the crew members in future vehicle design, in that the traditional role of direct manual control will have to be balanced against a role of supervisory control. The Cockpit Automation Technology program develops this dual role for the fighter/attack pilots (Mr. Kulwicki, 2829, 1982)

An articulated total body model has been developed using a highly specialized computer graphics technique. This model supports the development of advanced ejection seat concepts and escape technology. It predicts the body motion with respect to the seat, assesses the effect of seat/man dynamics, evaluates the effectiveness of various body restraints, and provides criteria for design of rocket thrust systems. The parameters incorporated into the model include seat geometry, restraint systems, crewmember body size and mass distribution characteristics, ejection acceleration, aircraft altitude, aircraft attitude, aircraft airspeed, seat rocket placement, rocket thrust, and human tolerance data of abrupt accelerations (Dr. Kaleps, 7231, 1982)

Noise impact technology program has developed an advanced version of NOISEMAP and NOISEFILE. The objectives of these two activities was to develop the technology required to predict community noise exposure caused by aircraft operations in proper physical-psycho-acoustic metrics. The NOISEMAP is a computer based model which inputs aircraft flight and ground operations, the meterological conditions, and the suppressors being used. The program outputs are noise contour maps with single event footprints, cumulative exposure, land areas exposed and the number of people either exposed or annoyed. The NOISEFILE uses magnetic tape to gather aircraft noise characteristics in flyovers, runups, and use of suppressors. The technical factors are sound pressure, duration effects, spectral content, psycho acoustic response, propagation and the aircraft power plant (Mr. Cole, 7231, 1982)

The standard USAF ejection seat is now the Advanced Concept Escape System called ACES II. It uses technology of the late 1960's and is certainly the best seat ever fielded by the USAF-- a tribute to the joint AFAMRL-ASD team that developed it between 1968 and 1974, using a controlled force catapult, a gyro controlled stabilizer rocket and a sustainer rocket to assure safe ejections from a wide variety of emergencies while minimizing the probability of injury due to ejection forces, seat tumbling or parachute opening shock. Computerized control now allows development of a more capable seat and AMD asked AFAMRL and AFWAL to jointly man an Advanced Development Program Office to demonstrate Advanced Crew Escape Technologies (CREST ADPO) to extend the safe ejection envelope to include higher speeds, higher sink rates and wider variety of adverse attitude, low-altitude emergencies. To do so required development of the first 6 degree-of-freedom human impact acceleration tolerance criteria in a transfer function formulation suited to mechanization in the adaptive digital flight controller. A flow stagnation windblast protection scheme was developed to simultaneously control aerodynamic forces on the seat occupant and seat drag coefficients. Finally, the Advanced Dynamic Anthropomorphic

Manikin (ADAM) program was initiated to insure availability of a suitable "live load" for demonstration ejection tests (Mr. Brinkley, Lt Col. Rock, Mr. Specker, Dr. Kaleps, 2868, 1983)

Anthropometric support to weapon system development is a critical factor in cockpit and equipment sizing. This Laboratory has maintained through the past forty years a singular expert capability which has been applied to a broad range of Air Force problems. Specifically, the sizing and critical fit testing of the constant stream of developments in personal protective equipment. Primary examples are chemical defense protective clothing for flying and ground crews, improvements in oxygen masks, protective helmets, pressure suits, fire fighter suits, uniform clothing, and aircraft mounted equipment. No other organization in the Air Force has this capability (Mr. Alexander, 7184, 1984)

The Strategic Avionics Crew Station Design Facility (SACDEF) conducts strategic mission simulations with computer controlled man-in-the-loop monitoring of system and aircrew performance. The mission scenarios and combat ready crews were supplied by Strategic Air Command (SAC). The output of this program was used by Strategic Air Command for crew station design modification and the development of combat tactics. The SACDEF is also used by the ASD-Deputy of Advanced Planning for studies of new weapon systems penetration ability and new automated avionics controls (Dr. Chubb, Mr. Sharp, Lt Col Brisby, 7184, 1984)

AWARDS

1970	Dr. Thomas Furness	AFSC Scientific Achievement
1970	Major John Simons	Alex C. Williams Jr. Award
1971	Mr. Jim Brinkley	AFSC Scientific Achievement
1971	Mr. Robert Powell	AFSC Scientific Achievement
1971	Dr. Clyde Replogle	AFSC Scientific Achievement
1971	Mr. Jerry Speakman	AFSC Scientific Achievement
1972	Mr. Charles Dempsey	NSPE Engineer of the Year
1972	Dr. Leon Kazarian	Eric Liljencrantz Award
1972	Mrs. Debbie Seifert	Patricia Keys Glass Award
1973	Mr. Phillip Kulwicki	AFSC Scientific Achievement
1973	Dr. Leon Kazarian	George-Schmorl Preis Award
1974	Dr. Henning von Gierke	Arnold D. Tuttle Award
1975	Mr. Charles Dempsey	Meritorious Civilian Service
1976	Mr. Jim Brinkley	NASA Group Achievement Award
1976	Major Jim Veghte	Legion of Merit
1977	Mr. William Albery	AFSC Scientific Achievement
1977	Col. Dan Johnson	Harry G. Armstrong Award
1978	Lt Col Wayne Kendall	Jabara Award
1980	A F A M R L	AF Outstanding Unit Award
1980	Mr. Charles Bates	AFSC Distinguished Civilian Service Award
1980	Mr. James Murphy	B. J. Katchman Award
1981	Mr. Jim Brinkley	GEICO Public Service Award
1981	Dr. Henning von Gierke	Distinguished Executive Award
1981	Dr. Joe McDaniel	Federal Employee of the Year
1981	Mr. Dan Repperger	Harry G. Armstrong Award
1982	Mr. Michael Gargas	Frank R. Blood Award
1982	Dr. Tom Moore	AFSC Scientific Achievement
1982	Mr. Richard McKinley	AFSC Scientific Achievement
1982	Dr. Mel Andersen	AFSC Scientific Achievement
1982	Mr. Richard McKinley	Arthur S. Fleming Award
1983	Mr. Charles Dempsey	Exceptional Civilian Service Award
1983	Mr. Jim Brinkley	Eric Liljencrantz Award
1983	Dr. Lee Task	Harry G. Armstrong Award
1983	Dr. Lee Task	AFSC Scientific Achievement
1983	Ms. Katherine Smith	Federal Woman of the Year Award
1983	Mr. Gil Kuperman	AFSC Scientific Achievement
1983	Mr. Bill Welde	AFSC Scientific Achievement
1984	Major William Keller	AFSC Scientific Achievement

1984	Mr. Eberhardt Privitzer	AFSC Scientific Achievement
1984	Mr. Larry Specker	AFSC Scientific Achievement
1984	Dr. Lee Task	Sloan Management Award
1984	Col. Michael McNaughton	AMA Science & Eng. Award
1984	Dr. Lee Task	Exceptional Civilian Service Award
1984	Mr. Lee Griffin	Exceptional Civilian Service Award
1984	Mr. Duane Starbuck	Exceptional Civilian Service Award

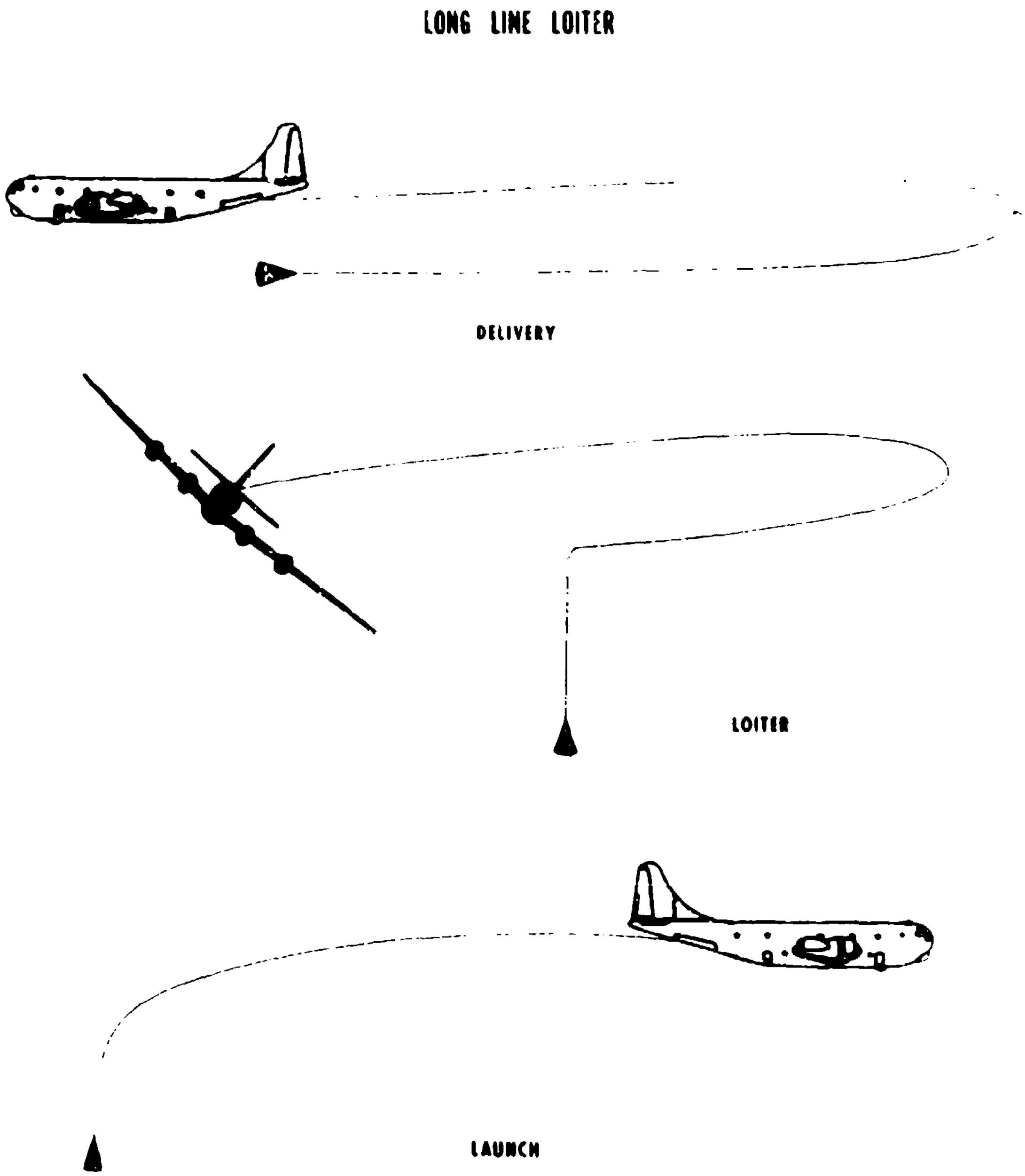


Fig V-1 Long line loiter flight maneuver modified and improved for military use by Major Simons.

Fig V-2 Captain Buckling holding the ground end of the long line attached to the circling aircraft.

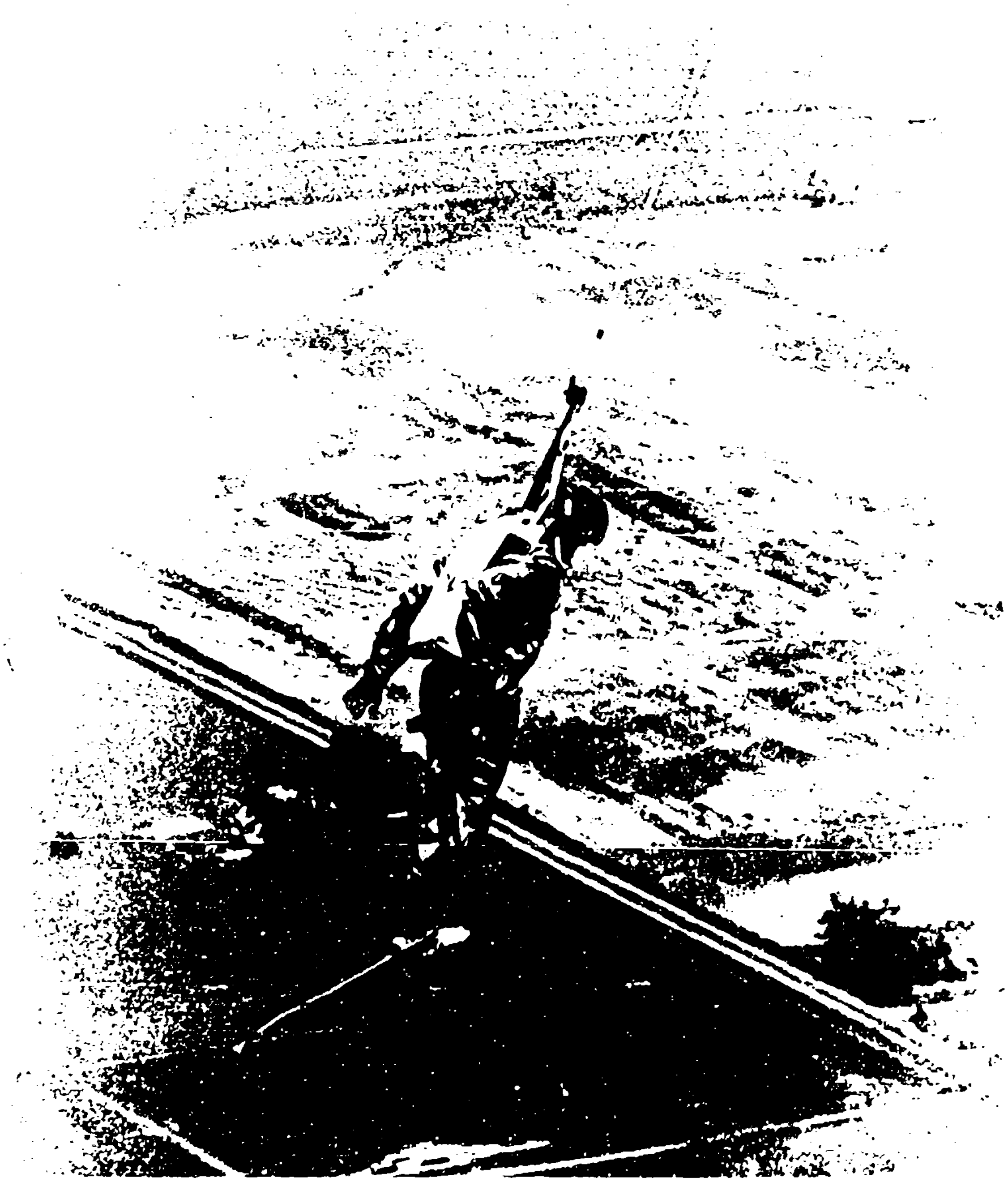


Fig V-3   Anthropomorphic dummy is being towed in trail following a pick-up from the ground by the long line loiter system.

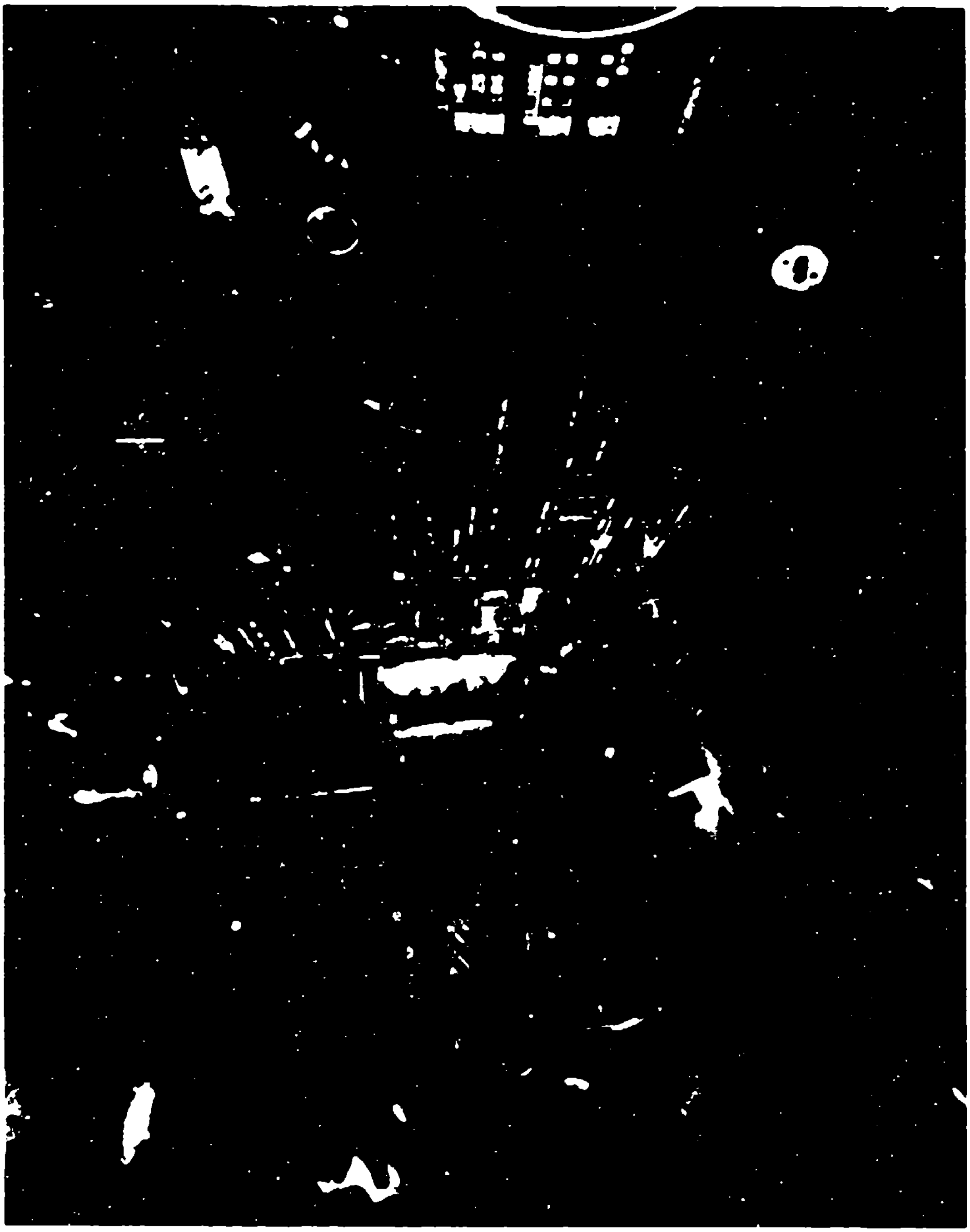


Fig V-4 SACDEF strategic mission simulator.

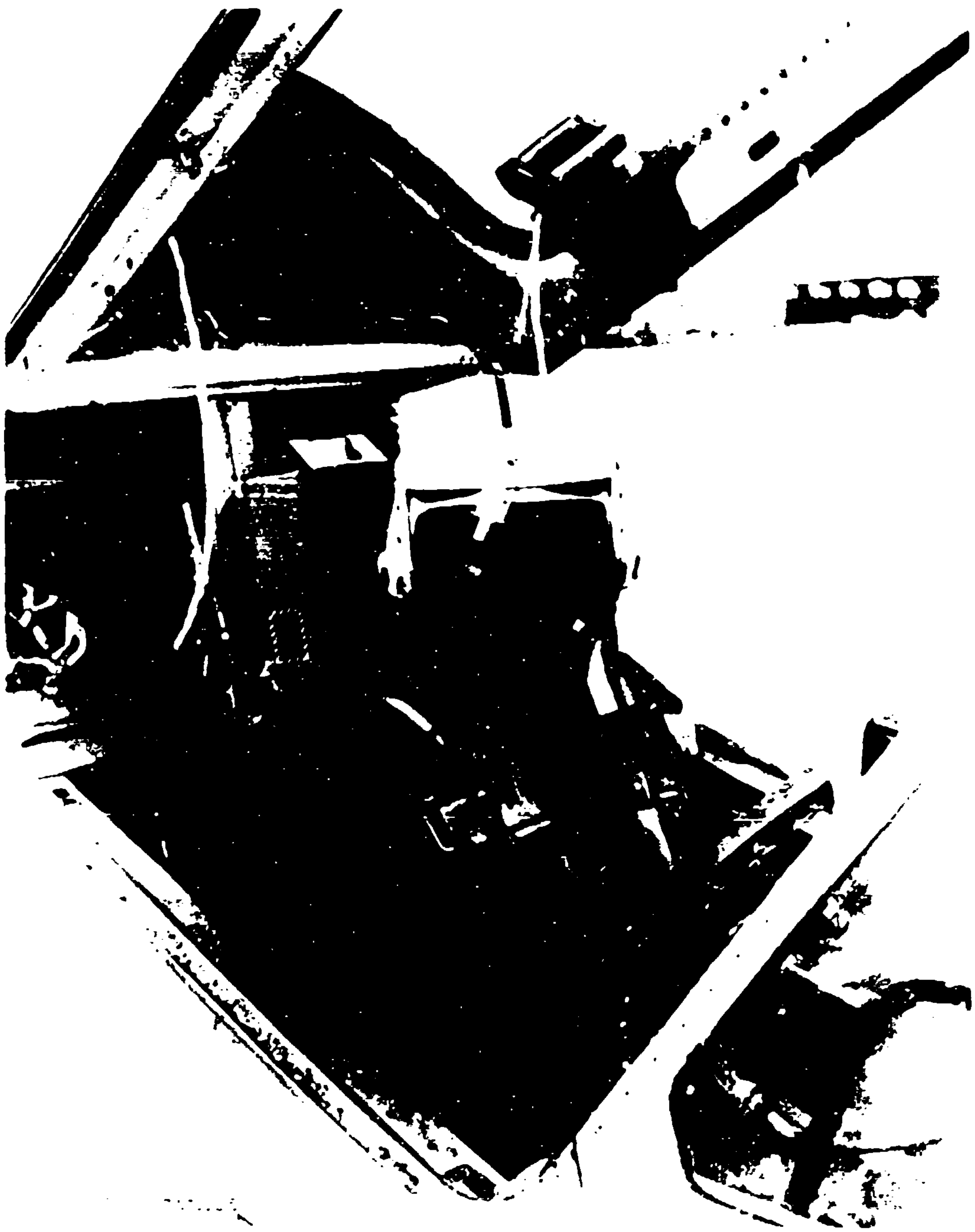


Fig V-5 First flight test of the helmet mounted sight in an F-101 aircraft at Tyndall AFB.

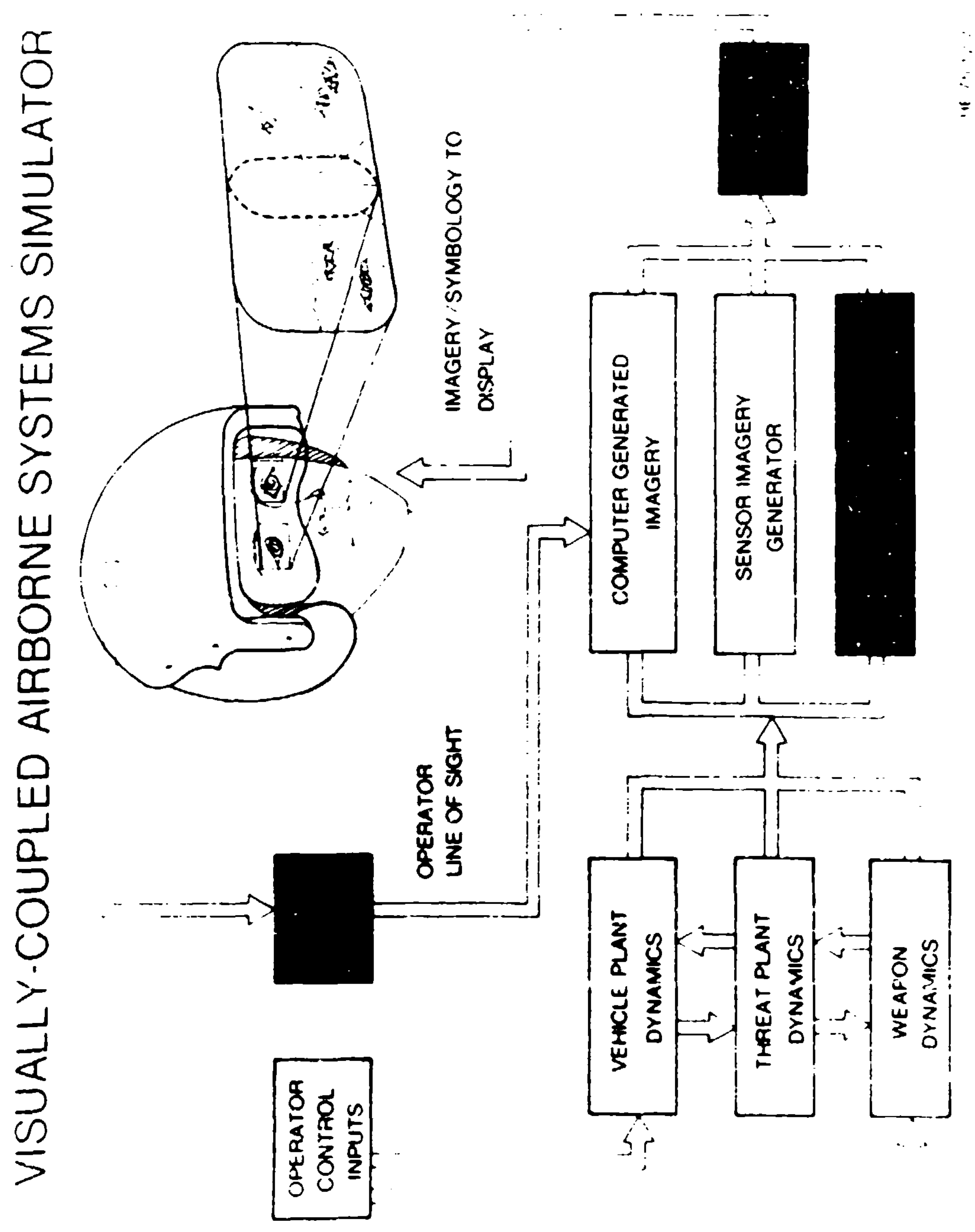


Fig V-6 Visually coupled airborne system simulator is a fundamental new approach to aircrew training.

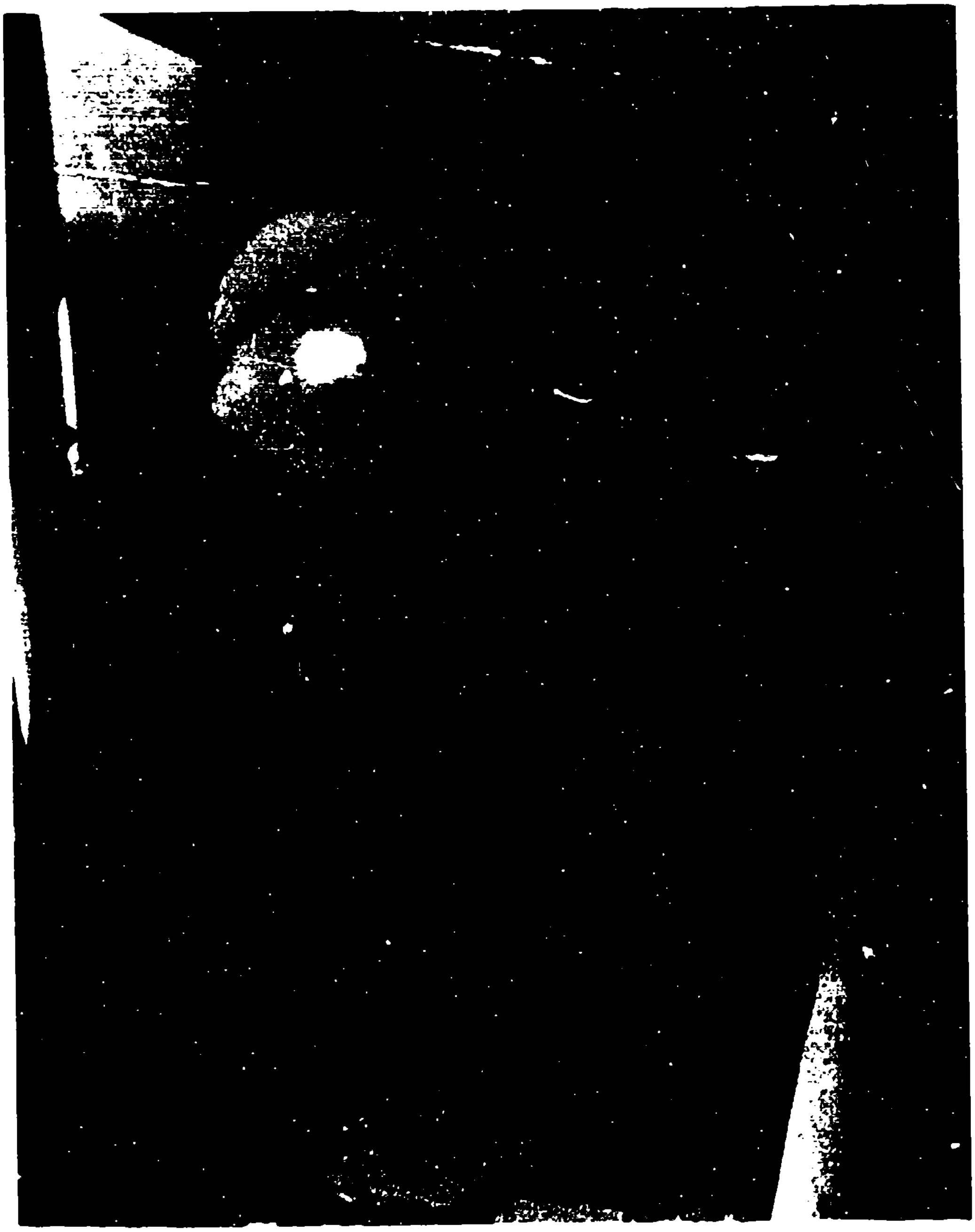


Fig V-7 Human engineering experiment using the VCASS in Bldg. 248.

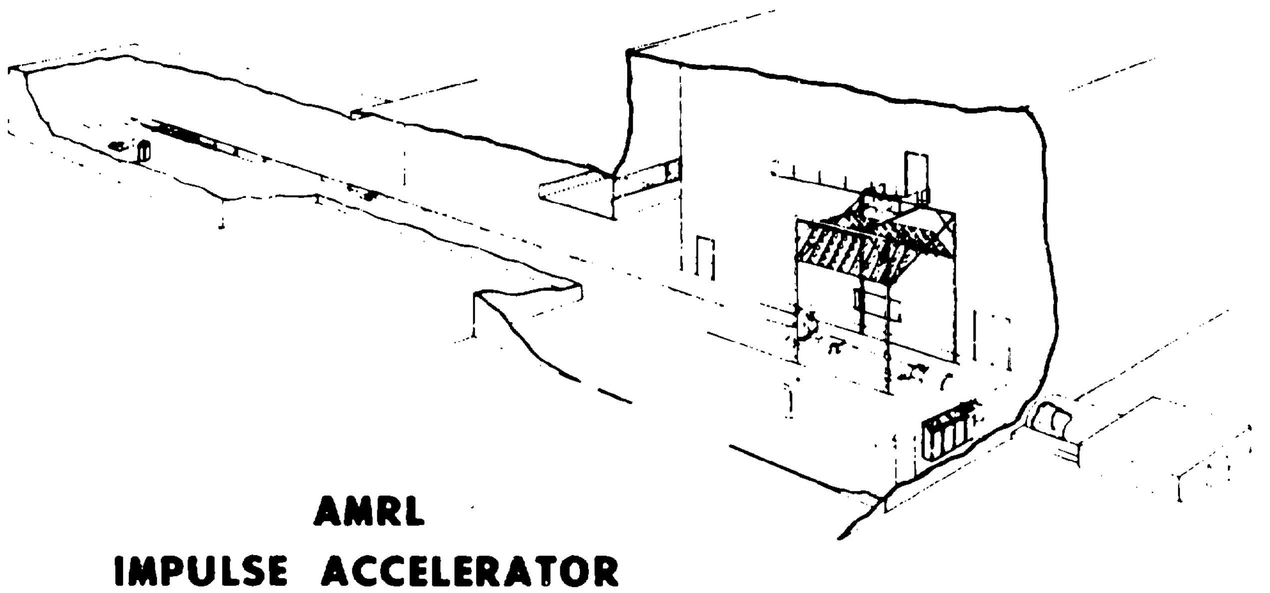


Fig V-8 The impulse accelerator is man-rated for abrupt acceleration experiments in Bldg. 824.

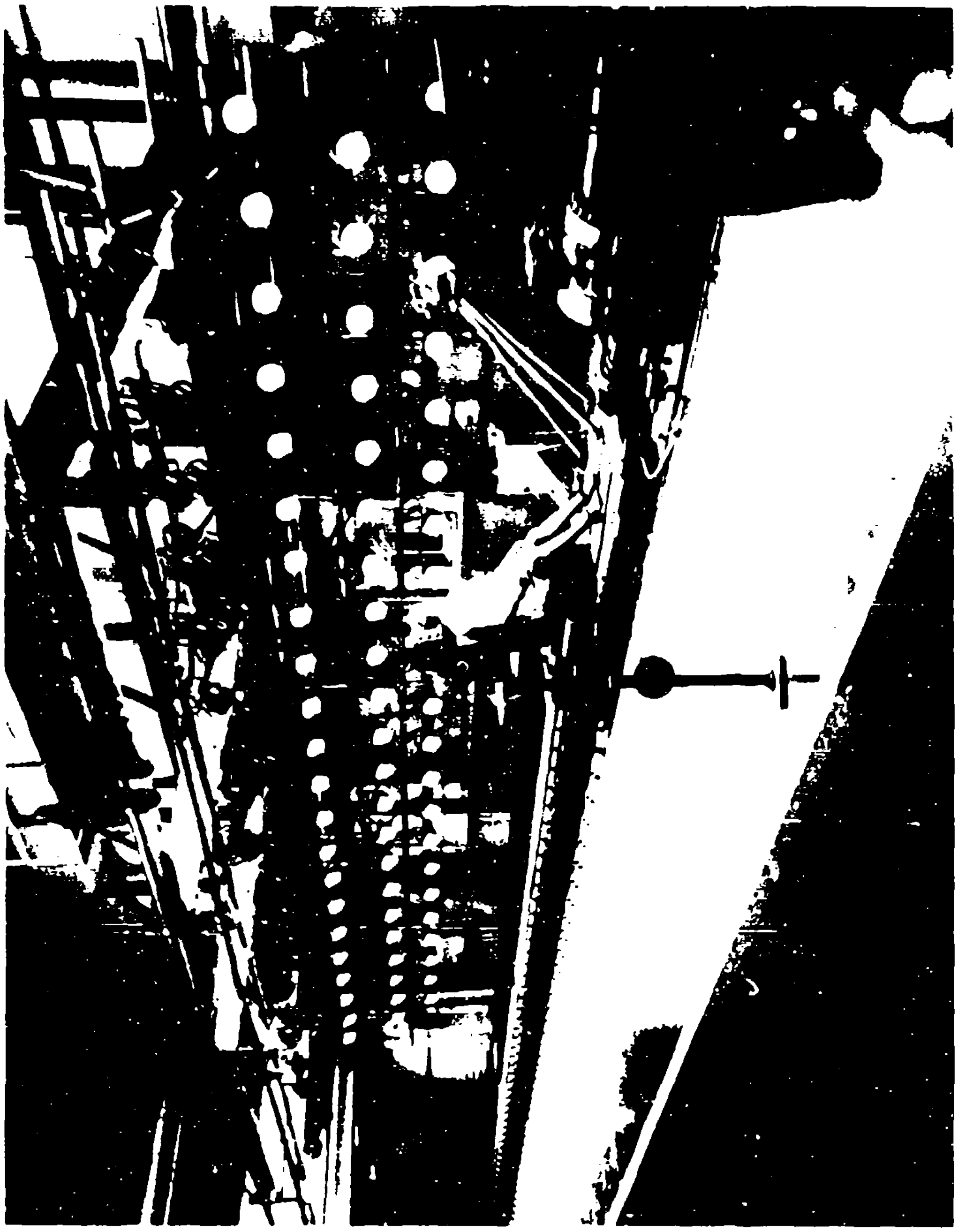


Fig V-9 Test dummy entering the deceleration device at the end of the impulse accelerator track.

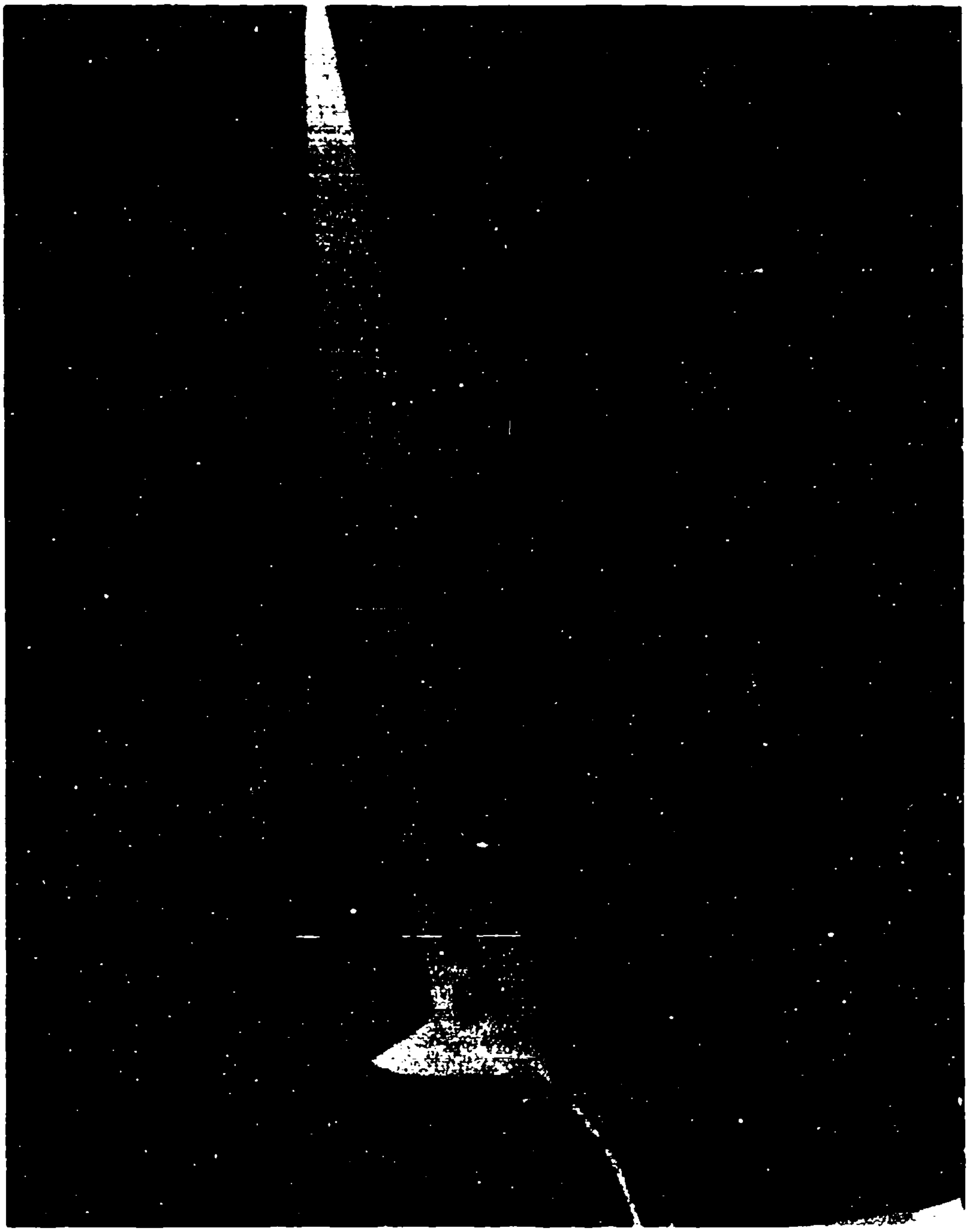


Fig V-10 F-16 canopy off windblast test in the wind tunnel at MACH 1.2

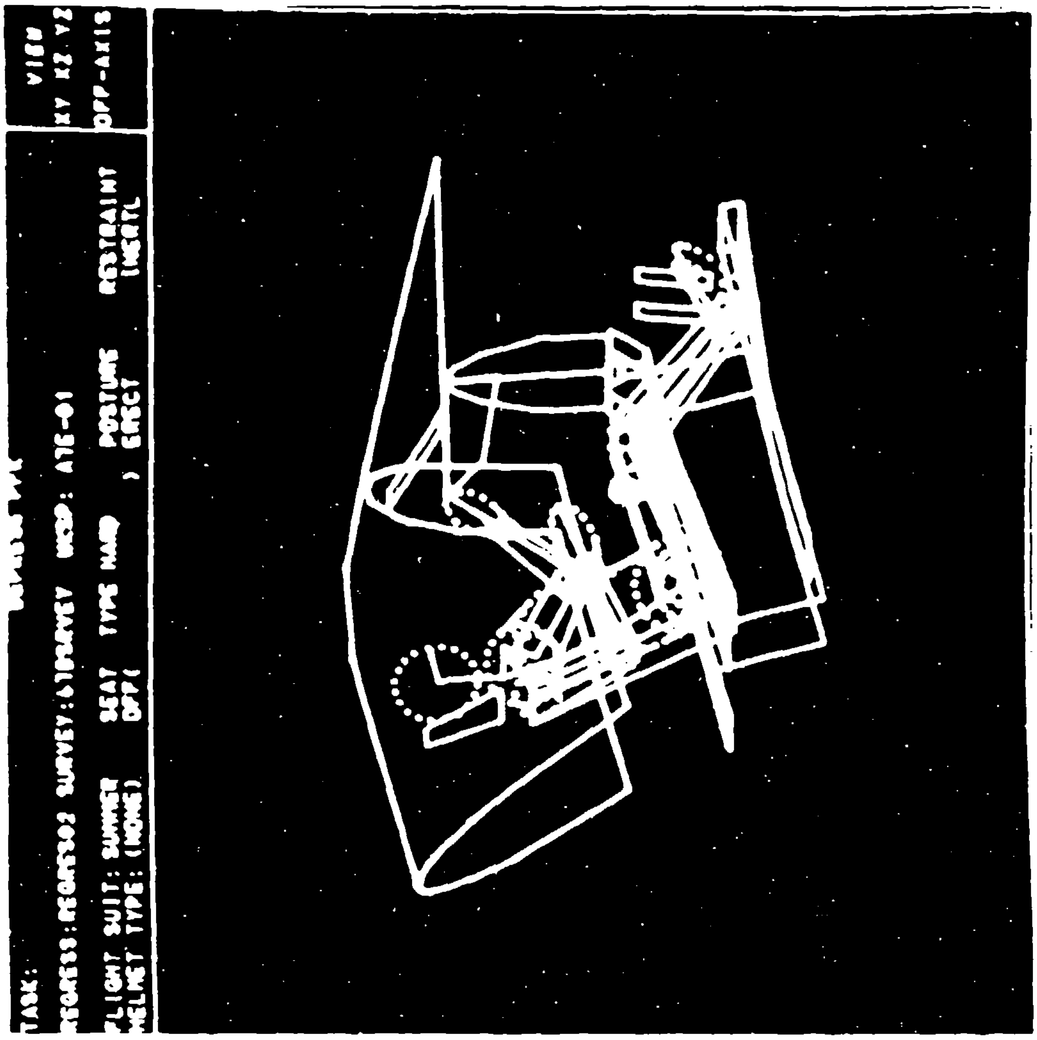


Fig V-11 First computerized graphics of anthropometric data using the HESS computer. (COMBIMAN)

Fig V-12 COMBIMAN graphics being used in cockpit design.

Fig V-13 Five man team conducting a real time flight simulation of an RPV mission on the HESS.

Fig V-14 Noise measurement survey of rocket engines during vehicle lift-off at Cape Kennedy, Fla.

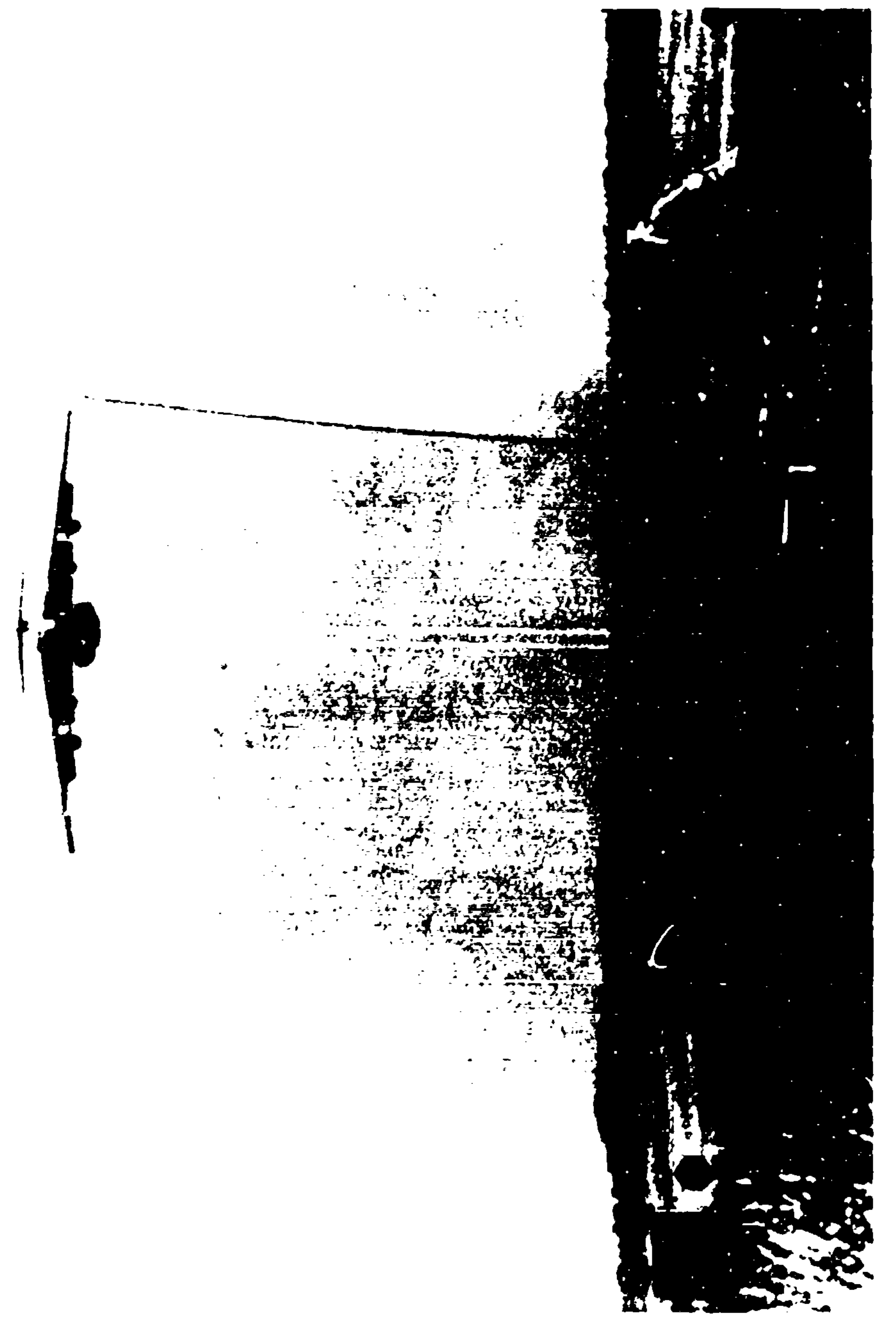


Fig V-15 Gathering aircraft noise data for update of the NOISEFILE program.

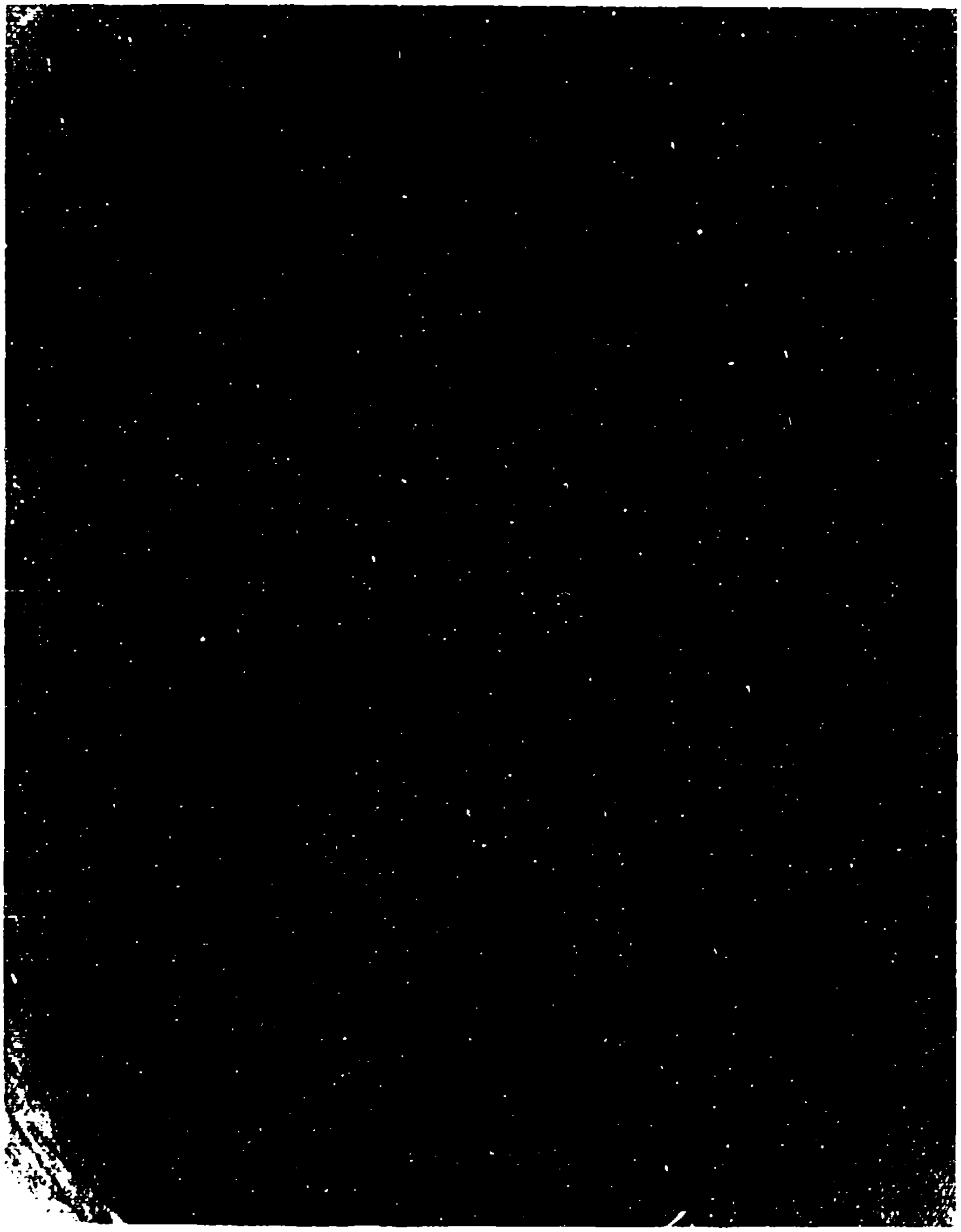


Fig V-16 First high acceleration cockpit design using the tiltable seat and computerized displays.

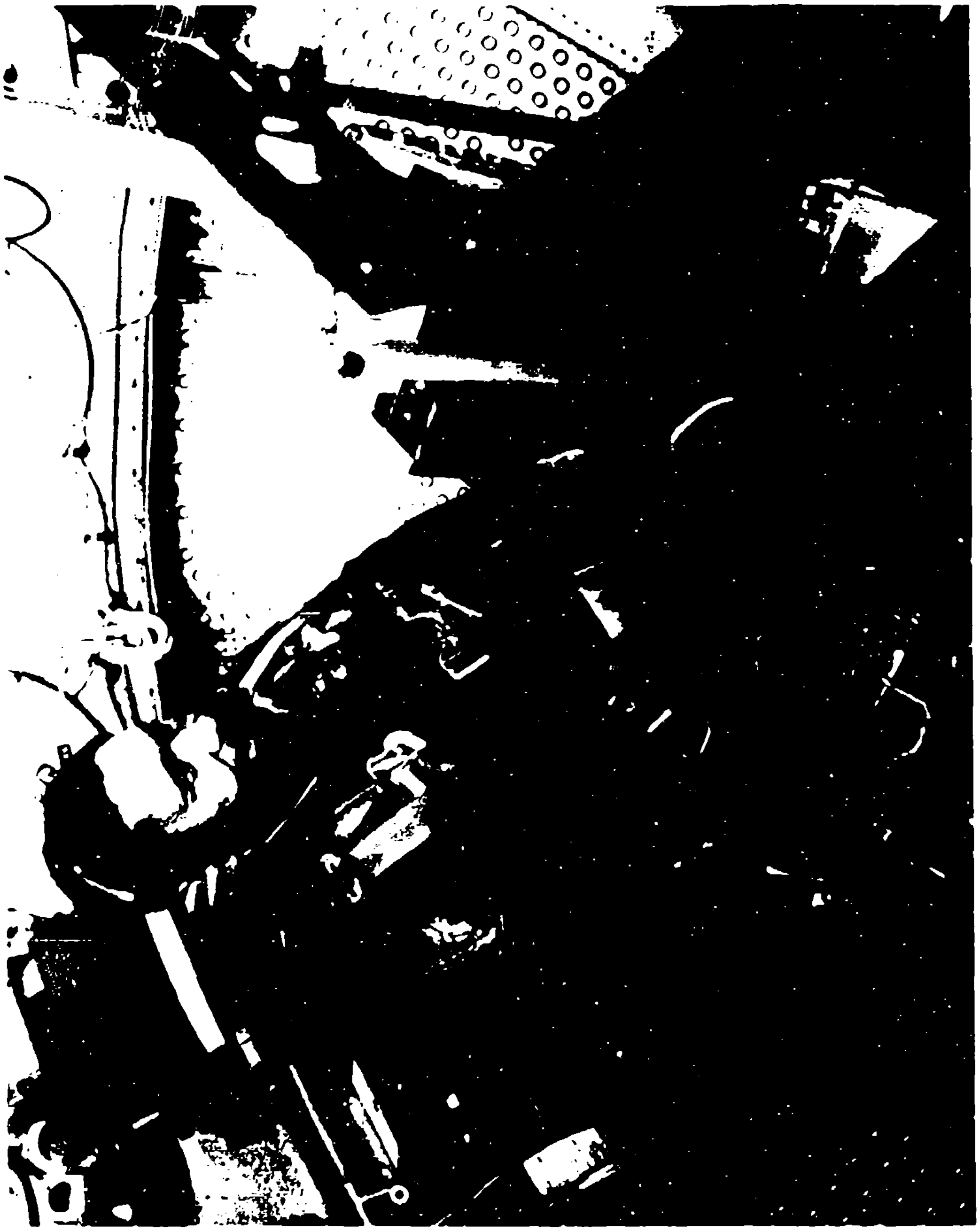


Fig V-17 Subject in the high acceleration cockpit seat while being exposed to +9G in the centrifuge.

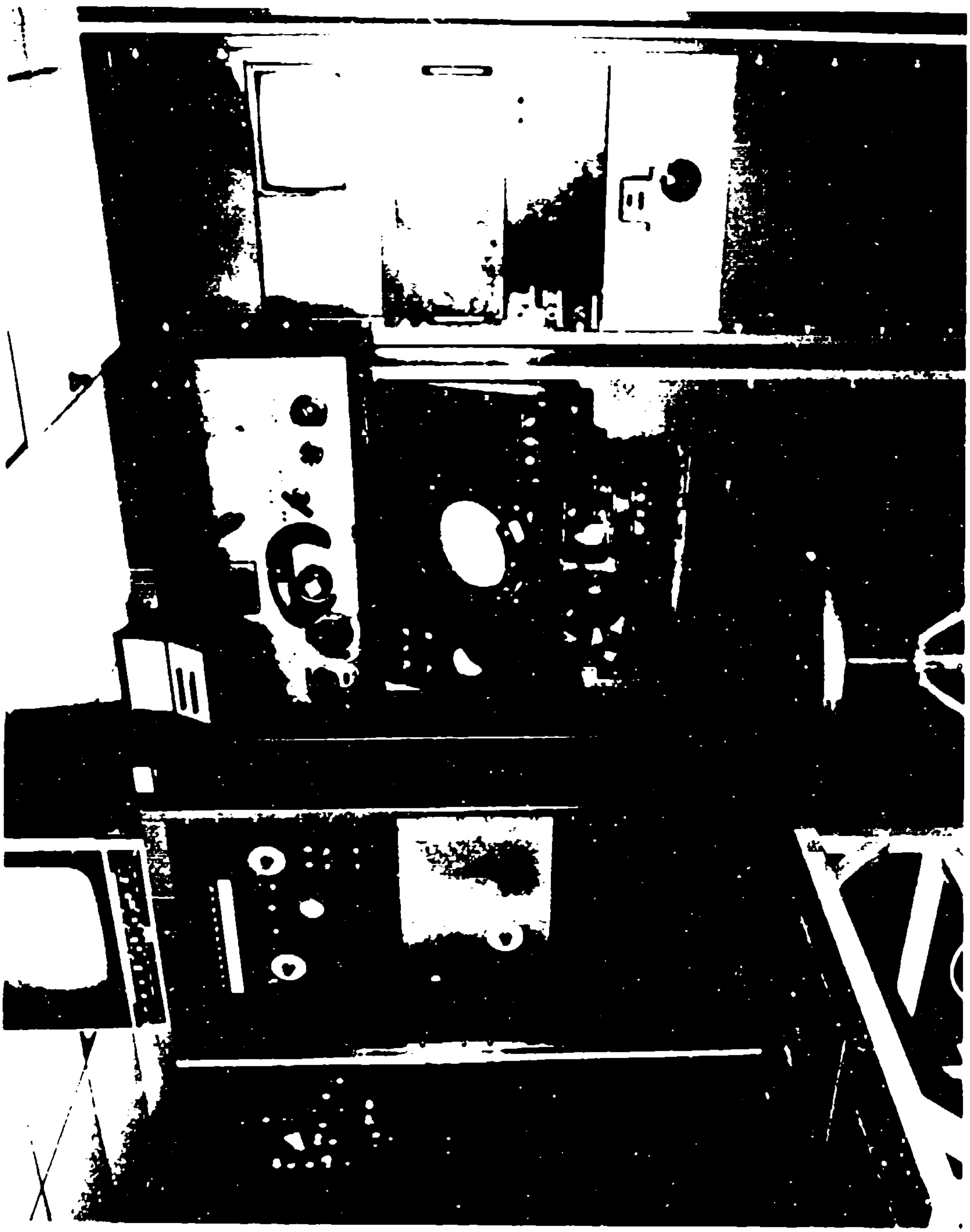


Fig V-18 AAA simulator used in human performance tests of defensive systems.

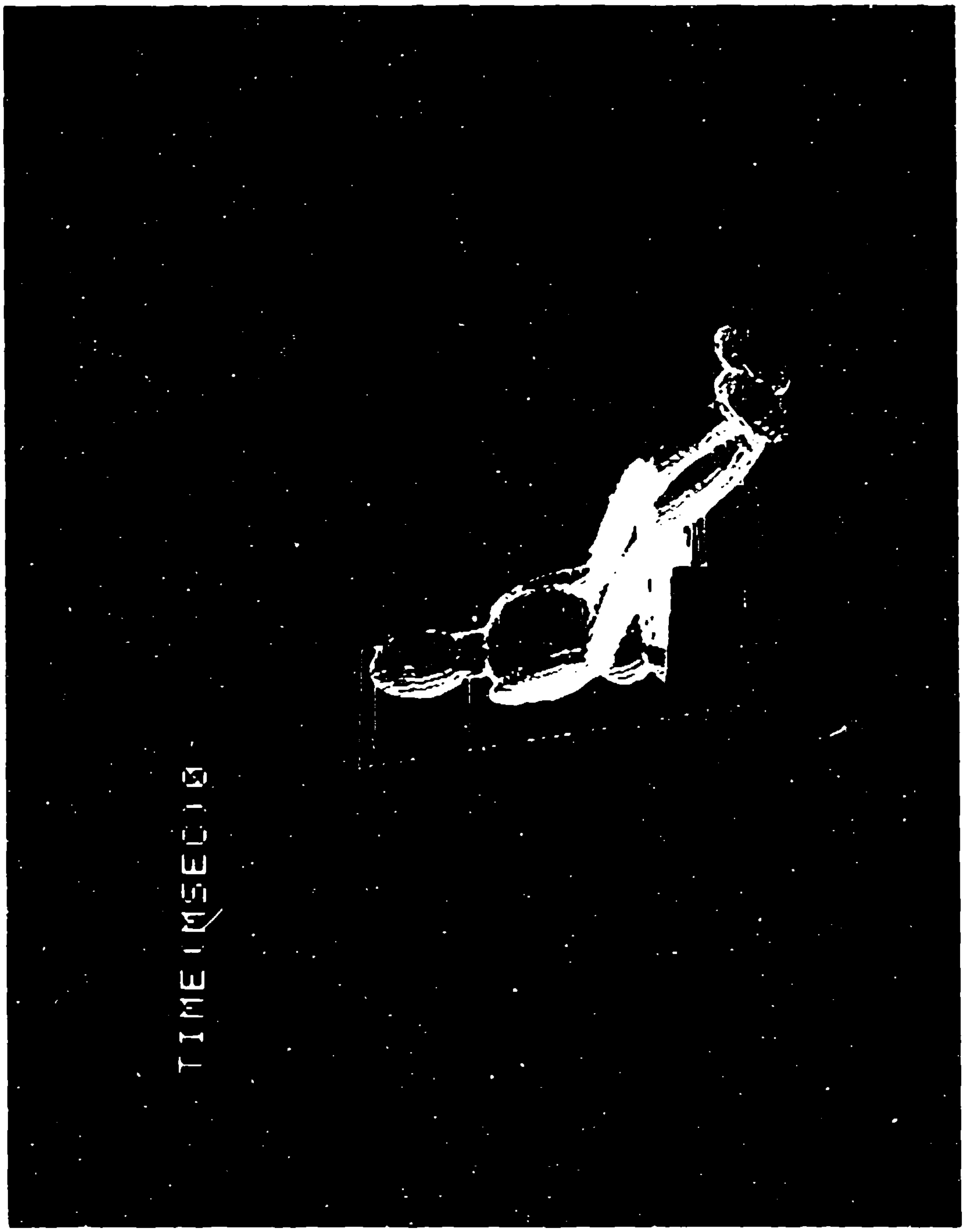


Fig V-19 First computer graphics of articulated total total body model used in analysis of ejection forces.

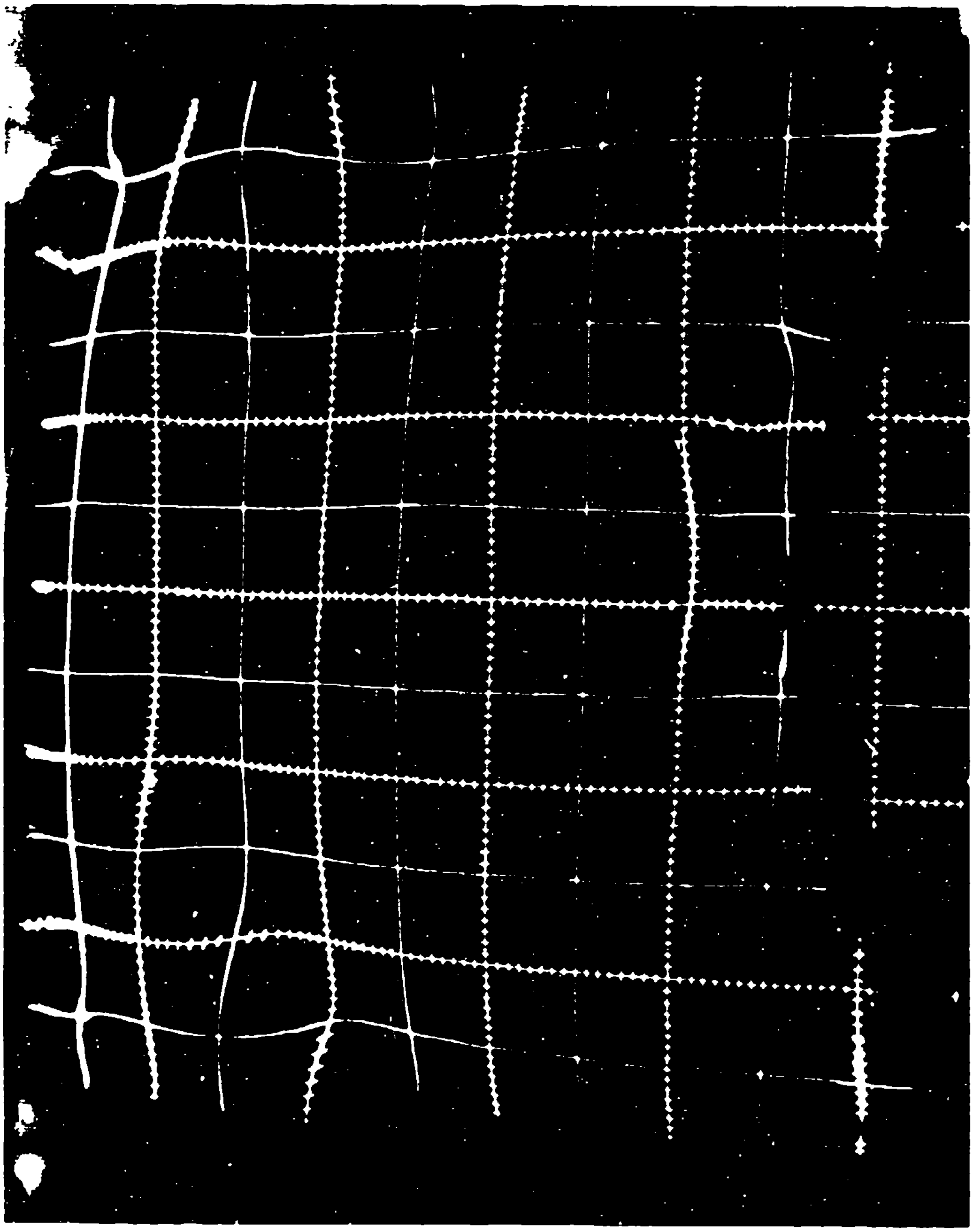


Fig V-20 F-111 windscreen distortion experiments.

Fig V-21 Multiple operator experiments in the voice communications research program.

Fig V-22 Study of rocket engine toxic products and their effects on plants and other agricultural type products.

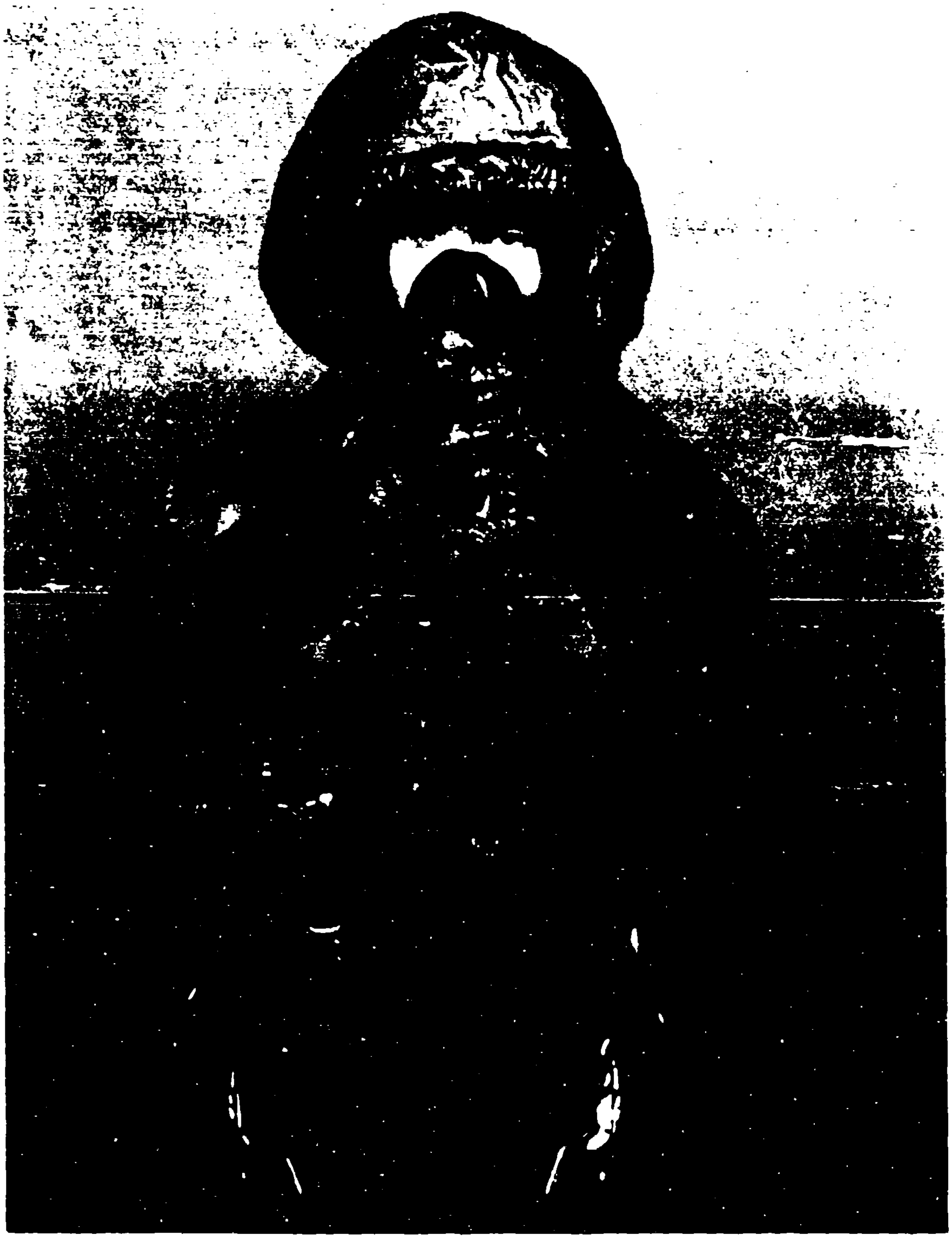


Fig V-24 Electron microscope used in the toxicological research programs.

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February 1, 1985

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Sears, Rhea, Mrs.	Secretary to Commander

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Wache, Robert, Capt		
Ward, Michael, MSgt		
NSBIT	**NOISE AND SONIC BOOM ADPO**	
Long, Gerald, Maj		

IN MEMORY

THE DEDICATED FEW WHO CLEARED THE PATH TO THE FUTURE

IM-1 Lt Colonel Elizabeth Guild

THE TYPICAL "CAN DO SPIRIT" OF THE LABORATORY

IN MEMORY

THE DEDICATED FEW WHO CLEARED THE PATH TO THE FUTURE

Miss Audrey Pease	Secretary to the Commander
Colonel Mike Sweeney	Biophysics Branch
Dr Fred Berner	Technical Director
Colonel Randy Lovelace	Commander
Dr Hans Mauch	Environment Section
MG Harry Armstrong	Founder, Aero Medical Laboratory
Mr Henry Seeler	Engineering and Development Branch
Dr Dean Chiles	Crew and Systems Section
Mr George Frost	Psychology Branch
M SGT Harold Lichty	Respiration Section
Mr Moses Draper	Drafting Section
Mr Don Rosenbaum	Respiration Section
Dr Horace Parrack	Coordinator, Noise and Vibration
Miss Bea Finkelstein	Nutrition Section
Mrs Edna Miller	Librarian
Mr Josh Chatham	Nutrition Section
Mr Konrad Wiseworm	Accessories Section
Captain Randall	Anthropology Section
Captain Harry Meyers	Anthropology Section
Mrs Marjorie Martin	Biophysics Branch
Mrs Julia Pettit	Acceleration Section
Dr Paul Fitts	Founder, Psychology Branch
Dr Otto Gauer	Acceleration Section
Mr Don Good	Engineering and Development Branch
Col Arthur Henderson	Vice Commander
Miss Patricia Leach	Operations Office
Miss Glenna Hawke	Biophysics Branch
Miss Helen Oster	Biophysics Branch
Mr Miles McLennan	Bio-electronics Section
Mr Ed Correll	Bio-electronics Section
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Mrs Betty Sullivan	Clothing Branch
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Mrs Virginia Coate	Personnel and Mail Section
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Mr Cornelius Dorsey	Lab Services Section
Lt Frank Hutchinson	Administration
Mrs Anna Hliaras	Biophysics
Miss Dorothy Leffel	Administration
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Mr Rey Middleton	Respiration Section
Mr John Sullivan	Lab Services Section
Lt Col Bob Summers	Medical and Sanitation Section
Cmdr. Harold Smedal	Respiration Section
Mr Carl Walthall	Lab Services Section
Mr Lonnie Yeary	Machine Shop
Colonel Kendricks	Commander
Dr Dwayne Kastens	Human Engineering

Dr Sheldon McLeod	Human Engineering
Dr George Wright	Human Engineering
Mr James Smithson	Human Engineering
Dr Adolph Marko	Biodynamics
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Mr Loren Pittman	Protective Equipment Branch
Dr. John Bowen	Human Engineering
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M/Sgt Harold Espensen	Human Engineering
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Dr. Donald Haines	Training Division
Col. Lloyd Hayes	Human Engineering
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Dr. Julian Morrissette	Human Engineering
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Lt/Col Frederick Thimm	Human Engineering
Capt Charles Urschel	Human Engineering
Mr. H. Richard Van Saun	Human Engineering
1/Lt Larrion Vickery	Human Engineering
Dr. James Welch	Human Engineering
Mr Craight Spradlin	Veterinary Medicine
Mr Auselus West	Toxic Hazards Division
Mr David Stewart	Toxic Hazards Division
Dr Otto Schueller	Protection Branch

EPILOGUE

"LOOK AHEAD WHERE THE HORIZONS ARE ABSOLUTELY UNLIMITED"

Robert E. Gross
Lockheed Corporation

This is an unfinished history about the continuing biotechnology research on manned flight vehicles. The United States leadership in aeronautics and astronautics continually dictates the future direction of flight based on the evolving technology in avionics, vehicle design, flight control and propulsion. This future direction can be easily summarized as; faster, higher and farther. Biotechnology is therefore challenged to the maximum limits of human tolerance and performance capability. MAN must always adjust and adapt to these new environments since the luxury of creative redesign is not available.

The first eighty five years of flight, from the 1900 Wright glider on the sand dunes of Kitty Hawk to Neil Armstrong on the Moon and space probes on Mars, has been without parallel in human history. If the next eighty five years are pursued as rapidly as the past, it is quite possible that MAN will be living in space for extended periods of time. This might be the ultimate challenge for biotechnology research. The past golden age of flight has established the AEROSPACE MEDICAL RESEARCH LABORATORY as the World leader in human factor criteria for manned aerospace vehicles. This leadership was obtained through the dedicated and heroic achievements of the many scientists who have passed through its doors. They, like Armstrong, are also the true pioneers, for they established base line knowledge which permits one to "LOOK AHEAD WHERE THE HORIZONS ARE ABSOLUTELY UNLIMITED."

BUILDINGS

The Aerospace Medical Research Laboratory has continually increased the size of the physical plant to accomodate the evolving mission responsibilities and increased acquisition of sophisticated simulators and testing equipment. Founded in 1935, it was originally located in the basement of Building 16. The rapid demands of the war years required a major relocation and the construction of new facilities. Buildings 29, 55, 196, 197, 198 were constructed in 1943-1944 and became known as the aeromedical complex at Wright Field. The complex was further expanded with the construction of Building 33 in 1947, and Building 248 in 1954. Since there was not additional land space within the complex the Laboratory was forced to continue it's building program at other locations on Wright Field. Building 824 was acquired in 1955, and Building 441 was constructed in 1957. These two structures are located on the east side of Wright Field approximately two miles away from the aeromedical complex. Building 79 located on the south side of Wright Field was acquired in 1965. The last new facility was the construction of Building 838 on the east side of Wright Field.

Since 1965, there have been extensive renovations or expansions of the existing buildings. Today the Laboratory is accomodated in the following structures;

Building 29	25333 square/ft.
Building 33	58696 square/ft.
Building 79	37251 square/ft.
Building 196	7680 square/ft.
Building 197	8082 square/ft.
Building 198	5847 square/ft.
Building 248	66576 square/ft.
Building 441	29311 square/ft.
Building 824	36351 square/ft.
Building 838	24502 square/ft.

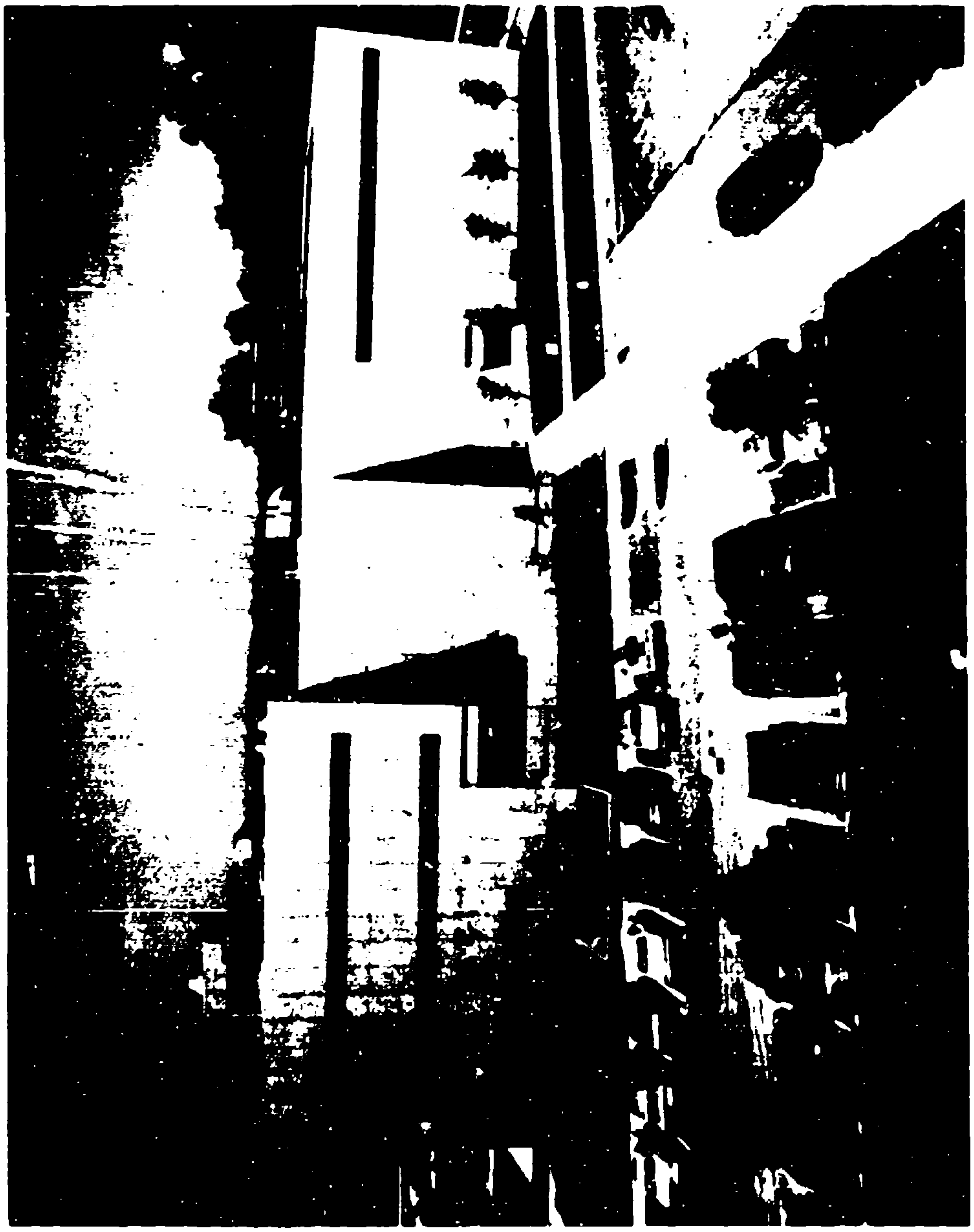

Fig B-1 Human engineering and biodynamics, Bldg 33.

Fig B-2 Toxic Hazards Division, Bldg 70

Fig B-3 Human Engineering Division, Bldg 248

Fig B-4 Biodynamics/Bioengineering Division, Bldg 441

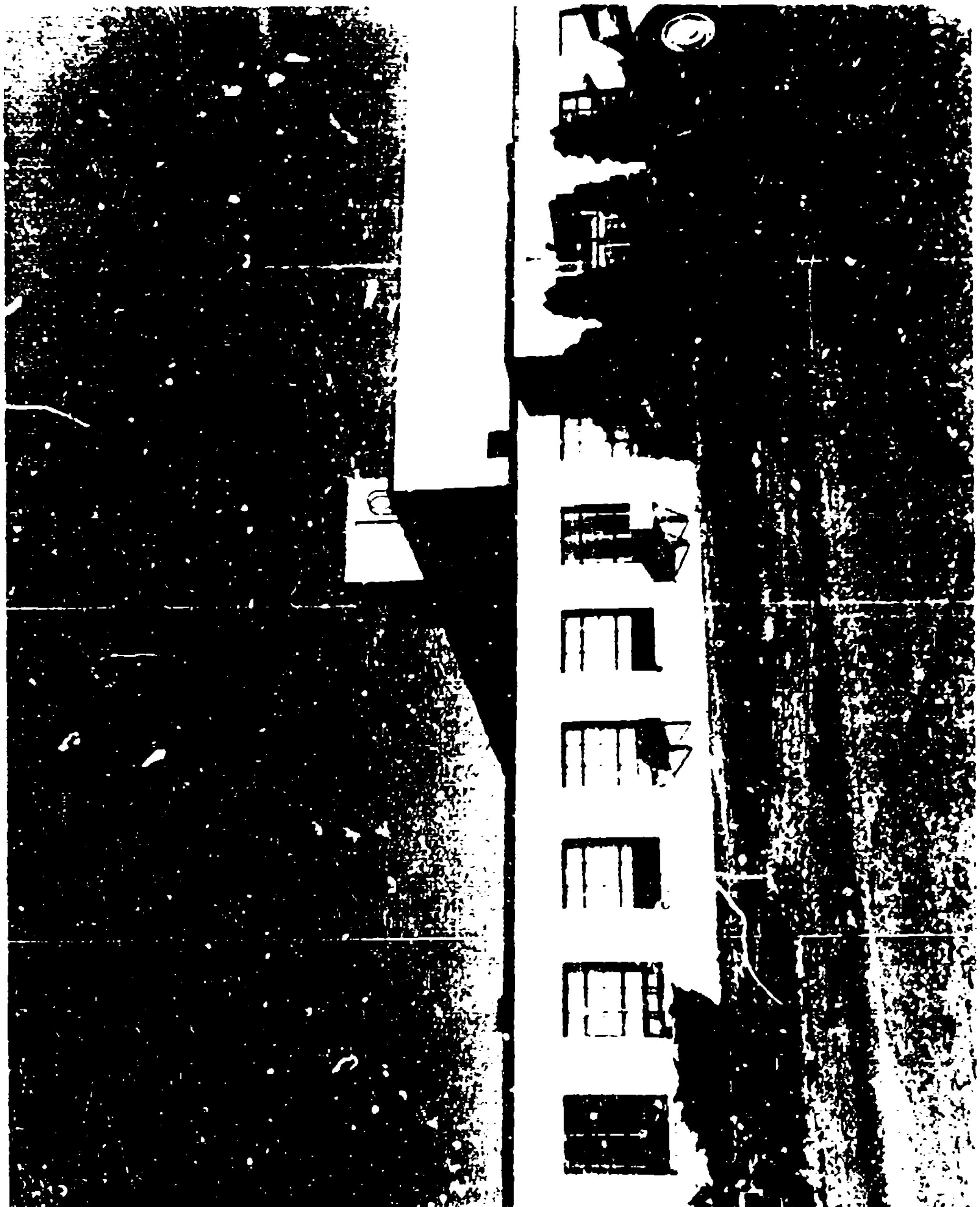

Fig B-5 Biodynamics Research, Bldg 824

Fig B-6 Veterinary Sciences Division, Bldg 838

REFERENCES

1. Engineering History, 1917-1978, McCook Field to the Aeronautical Systems Division Albert Misenko, History Office, Aeronautical Systems Division, WPAFB Ohio
2. A Chronological History of Aviation Medicine Lt/Col Beaven, School of Aviation Medicine, Randolph Field, Texas
3. History of the Aerospace Medical Research Laboratories Joan Robinette, STINFO, A.F. Aerospace Medical Research Laboratory, WPAFB, Ohio
4. History of the Aerospace Medical Division John Bullard, History Office, Brooks AFB, Texas
5. Medical Support of the Army Air Forces in World War II Mae Link, Office of the Surgeon General, USAF, Washington D.C.
6. Principles and Practice of Aviation Medicine Major Harry Armstrong, Williams & Wilkins Co. Baltimore, Maryland
7. U.S. Army Aircraft 1908-1946 James Fahey, Ships & Aircraft, New York N.Y.
8. United States Army and Air Force Fighters 1916-1961 Lt/Col Brown, Harleyford Publications Limited, Letchworth, England
9. Technical Reports 1935-1946 Aerospace Medical Research Laboratory, WPAFB, Ohio
10. The Physiological Requirements of Sealed High Altitude Aircraft Compartments ACTR #4165 Captain Harry Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
11. The Effect of Acceleration on the Living Organism ACTR #4362 Armstrong, Heim, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
12. Design and Use of Anti-G Suits and their Activating Valves in World War II AAFTR #5433 Major Hallenbeck, Aero Medical Laboratory, Wright Field, Dayton Ohio
13. Test of Oxygen Pressure Flying Suit for High Altitude Flying EO666-2, Serial #I-54-431, June 21, 1934 Nesbitt, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
14. Test of Oxygen Pressure Flying Suit for High Altitude Flying EO666-2, Serial #I-54-458, August 27,1934 Nesbitt, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
15. Appointment of Board of Officers to Study Merits of Liquid and Gaseous Oxygen for A.C. use at High Altitude Memorandum #50, January 24,1935 Hoffman, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
16. Bone Conduction of Aircraft Sound and Vibration EO664-1 Serial #X-54-219, January 31,1935 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
17. The Effect of Cold Temperature on Personnel Flying Efficiency Serial #X-64-226, March 1,1935 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
18. Trip to Washington, D.C. EO664-1 Serial #X-54-246, April 22,1935 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
19. Conference with Commandant, School of Aviation Medicine, Randolph Field, Texas Serial #X-54-246-A1, May 13,1935 Armstrong, Equipment Branch, Engineering Section, Dayton Ohio
20. A Study of the Merits of Liquid and Gaseous Oxygen for Air Corps use at High Altitudes Serial #X-54-231, May 16,1935 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio

21. Trip to Langley Field, Va. to Confer with the GHQ Air Force Staff on Problems of Physiological Research as Related to Flying Efficiency of Personnel Serial #X-54-2, June 22,1935 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
22. Trip to Harvard University, Boston, Massachusetts EO903-1 Serial #Q-54-5, November 30,1935 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
23. The Oxygen Equipment of Miss Alice M. Gibson of New York City EO660-1-53 Serial #X-54-203, December 6,1935 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
24. Pilot Stature EO664-1-265 Serial #Q-54-2-A1, December 11,1935 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
25. The Effect of Barometric Changes on the Ear and Accessory Nasal Sinuses EO635-1 Serial #Q-54-10, February 8,1936 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
26. Compression Tests on Human Teeth EO653-1-11, August 14,1936 Warner, Chief, Physical Test Unit, Materials Branch, Engineering Section, Wright Field, Dayton Ohio
27. The Effect of Flight at High Altitude on Teeth EO653-1-11 Serial #Q-54-7, August 31,1937 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
28. Development of Gas Oxygen Light Weight Cylinders, Gas-Oxygen Regulators and Valves, and an Oxygen Mask EO660-1-53 Serial #X-54-203, September 25,1936 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
29. Report on Rigid Crash Helments December 12,1936 Irvin, Flying Branch, Administration Section, Wright Field, Dayton Ohio
30. Altitude Tolerance EO653-1-19 Serial #Q-54-35, July 15,1937 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
31. Study to Determine the Absorption Rate of CO into the Blood at High Altitude EO653-1-18 Serial #Q-54-33, October 28,1937 Heim, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
32. The Effect of Anoxemia on the Adrenal Glands EO653-1-24 Serial #Q-54-49-A1, January 15,1938 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
33. The Effects of Decreased Barometric Pressures on the Living Organism EO653-1 Serial #Q-54-62, March 25,1938 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
34. Water Loss in the Body at High Altitudes EO653-1-22 Serial #Q-54-50, March 23,1939 Heim, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
35. Physiological Problems in Aviation EO653-1 Serial #Q-54-91, March 25,1939 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
36. Unsataisfctory Report Serial #40-1869, dated October 27,1939, re dope,paints, and related materials. EO354-653-4 Serial #U-EXP-M-54-653-56, November 22,1939 Armstrong, Equipment Branch, Engineering Section, Wright Field, Dayton Ohio
37. Engineering Psychology in the United States AMRLTR 68-198, October 1968 Grether, Aerospace Medical Research Laboratory, WPAFB, Ohio
38. Psychological Research on Equipment Design AD651-795, 1947 Fitts, Psychology Branch, Aero Medical Laboratory, Wright Field, Dayton Ohio
39. Engineering Anthropology: Past, Present, and Potential Hertzberg, Anthropology Section, Aero Medical Laboratory, WPAFB, Ohio
40. Human Problems in Escape from High Speed Aircraft Savely, Biophysics Branch, Aero Medical Laboratory, WPAFB, Ohio
41. Oral History Interview of Major General Harry Armstrong, April 20,1976 Bullard, Aerospace Medical Division, Brooks AFB, Texas

42. Oral History Interview of Raymond Whitney, October 27,1977 Bullard, Aerospace Medical Division, Brooks AFB, Texas

43. Oral History Interview of Dr. John Heim, October 24,1977 Bullard, Aerospace Medical Division, Brooks AFB, Texas

44. Oral History Interview of Dr. Walter Grether, October 25,1977 Bullard, Aerospace Medical Division, Brooks AFB, Texas

45. Oral History Interview of Mr. Ernest Martin, October 26,1977 Bullard, Aerospace Medical Division, Brooks AFB, Texas

46. Oral History Interview of Dr. Henning vonGierke, October 25,1977 Bullard, Aerospace Medical Division, Brooks AFB, Texas

47. Oral History Interview of Dr. Hans Oestreicher, October 21,1977 Bullard, Aerospace Medical Division, Brooks AFB, Texas